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FINAL

PHASE I RFI/RI WORK PLAN

ROCKY FLATS PLANT

WOMAN CREEK PRIORITY DRAINAGE
(Operable Unit No. 5)

VOLUME I

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

ENVIRONMENTAL RESTORATION PROGRAM

August 1991

REVIEWED FOR CLASSIFICATION/UCNI
By
Date 8/ /91

22506E/R1.TS 08-28-91/RPT/4

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ADMIN RECORD

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LIST OF ACRONYMS

The following is a list of acronyms used throughout this work plan.

ACL	Alternative Concentration Limit
AEC	Atomic Energy Commission
ARAR	Applicable or Relevant and Appropriate Requirements
AWQC	Ambient Water Quality Criteria
BCF	Bioconcentration Factor
BNA	Base-neutral acid extractable organics
BRAP	Baseline Risk Assessment Plan
CAD	Corrective Action Decision
CCR	Colorado Code of Regulations
CDH	Colorado Department of Health
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CMP	corrugated metal pipe
CMS	corrective measures study
CRP	community relations plan
CWA	Clean Water Act
DOE	Department of Energy
DQO	data quality objective
EEP	Environmental Evaluation Plan
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ER	environmental restoration
ERDA	Energy Research and Development Administration
FIDLER	Field Instrument for Detection of Low Energy Radiation
FS	feasibility study
FSP	field sampling plan
GAC	granular activated carbon
GC	gas chromatograph
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
HSP	Health and Safety Plan
HSU	Hydrostratigraphic unit
IAG	Interagency Agreement
IHSS	Individual Hazardous Substance Site
IRIS	Integrated Risk Information System
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MSL	mean sea level
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
PARCC	precision, accuracy representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PCE	tetrachloroethylene
PID	photoionization detector
QAA	Quality Assurance Addendum

QA/QC	Quality Assurance/Quality Control
QAPjP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFEDS	Rocky Flats Environmental Database System
RFI	RCRA facility investigation
RI	remedial investigation (CERCLA)
ROD	Record of Decision
SAS	Special Analytical Services
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act of 1986
SID	South Interceptor Ditch
SDWA	Safe Drinking Water Act
SOP	Standard Operating Procedure
SOPA	Standard Operating Procedure Addendum
TAL	target analyte list
TBC	to be considered
TCA	trichloroethane
TCE	trichloroethylene
TCL	target compound list
TDS	total dissolved solids
TIC	tentatively identified compounds
TOC	total organic carbon
UV	ultraviolet
VOA	volatile organic analysis
VOC	volatile organic compounds
WQC	Water Quality Criteria
WQCC	Water Quality Control Commission

This document presents the work plan for the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the Woman Creek drainage (Operable Unit Number 5) at the Rocky Flats Plant, Jefferson County, Colorado. This work plan includes a field sampling plan (FSP) that presents the investigation planned to evaluate the presence or absence of contamination at Individual Hazardous Substance Sites (IHSSs) within the Woman Creek drainage. The FSP developed in this work plan is based on the requirements of the Interagency Agreement (IAG) amongst the Department of Energy, Environmental Protection Agency, and the State of Colorado Department of Health and what additional work is needed to initially assess each IHSSs. Ten IHSSs are located in Operable Unit Number 5 (OU5). They are the Original Landfill (IHSS 115), the Ash Pits (IHSSs 133.1-133.4), the Incinerator (IHSS 133.5), the Concrete Wash Pad (IHSS 133.6), Detention Ponds C-1 and C-2 (IHSSs 142.10 and 142.11), and the Surface Disturbance (IHSS 209). Two additional surface disturbances have been identified and included in this work plan. These areas are located south of the Ash Pits and west of IHSS 209.

The schedule and the sequence of work for completing the OU5 investigation is specified in the IAG and is outlined below to provide background on the requirements for the OU5 RFI/RI. The IAG states that each OU, including OU-5, may proceed through several phases of investigation dependent on the information gathered to characterize the OU (Section I.B.9, IAG Statement of Work). For OU5, the IAG requires that DOE submit a draft Phase I RFI/RI Workplan, in accordance with the requirements for RFI/RI Workplans, to EPA and the State for review and comment (this document was submitted in April 1991). DOE has subsequently revised this draft RFI/RI Workplan to address all comments submitted by EPA and the State, and is resubmitting this RFI/RI Workplan to EPA and the State for review and joint written approval.

Following completion of the Phase I work plan the IAG requires that the results of the Phase I RFI/RI, for OU-5 be documented within a draft Phase I RFI/RI report. This draft RFI/RI report will include a Preliminary Site Characterization and will also recommend work to be performed for the Phase II investigation. The IAG specifies that this draft Phase I report be submitted to EPA and the state for review with DOE to address their comments and resubmit a Final Phase I RFI/RI report for EPA and/or the State review and approval. DOE is not to commence the next investigatory phase prior to receiving approval of the Final Phase I Report for OU-5 and approval of Phase II RFI/RI Workplans.

The IAG specifies that the priority and schedule for the Phase II RFI/RI investigations for OUs 3, 5, 6, 8, 12, 13, 14, 15, and 16 will be determined after evaluating the Final Phase I RFI/RI Reports for the operable units. If EPA and/or the state determine that no further investigatory work is required for OU5 after the Phase I investigation is complete, EPA and/or the state shall approve the Final Phase I RFI/RI

Report as a Final RFI/RI Report. The field investigations for OU5 will be considered complete after approval of a Final RFI/RI Report.

Section 1.0 of this work plan presents introductory information and a general characterization of the region and plant site. In addition, the regional geology and hydrology at Rocky Flats are discussed. Section 2.0 presents descriptions of the site physical characteristics, histories and previous investigations, available information concerning the nature and extent of contamination, and conceptual models for the IHSSs. This initial characterization forms the basis for establishing data needs, data quality objectives (DQOs), and developing an FSP for each IHSS. Section 3.0 presents applicable or relevant and appropriate requirements (ARARs) developed for OU5. Section 4.0 establishes data needs and DQOs considering site characteristics and conceptual models of each IHSS in OU5. Section 5.0 outlines RFI/RI tasks to be performed. Section 6.0 presents the schedule for these tasks. A Field Sampling Plan, based on the requirements of the IAG, is presented in Section 7.0 to satisfy the data needs and DQOs identified in Section 4.0. The Baseline Risk Assessment Plan (BRAP) and Environmental Evaluation Plan (EEP) are presented in Sections 8.0 and 9.0, respectively. A Quality Assurance Addendum (QAA) and Standard Operating Procedure Addenda (SOPA) are presented in Sections 10.0 and 11.0, respectively. A list of references is presented in Section 12.0.

The initial step in the development of the OU5 RFI/RI work plan was a review of existing information. Available historical and background data for each IHSS were collected through a literature search and a review of the Rocky Flats Environmental Database System (RFEDS). Only a few limited investigations have been conducted at OU5 in the past. These investigations include a germanium gamma radiation survey at the Original Landfill (IHSS 115), sediment sampling in Woman Creek, ongoing surface water, groundwater and sediment sampling programs along Woman Creek and the South Interceptor Ditch (SID), and the Plant-wide Ambient Air Monitoring Program.

Data quality objectives have been developed for this Phase I investigation. DQOs are qualitative and quantitative statements that describe the quality and quantity of data required by the RFI/RI. The DQO process is divided into three stages. Through application of the DQO process, site-specific RFI/RI goals are established and data needs are identified for achieving these goals.

After assessing the existing information for OU5, the following objectives of the Phase I RFI/RI have been identified:

- Characterize the physical and hydrogeologic setting of the IHSSs
- Assess the presence or absence of contamination at the sites
- Characterize the nature and extent of contamination at the sites, if present
- Support the Phase I Baseline Risk Assessment and Environmental Evaluation

Within these broad objectives, site-specific data needs have been identified based on preliminary identification of contaminants potentially present at each IHSS and the data needs for the Phase I Baseline Risk Assessment and Environmental Evaluation. The FSP presented in this work plan is based on the data needs and the requirements of the IAG. The FSP for each IHSS requires a combination of screening activities, sampling of soils, sediment and surface water, and well installation and sampling. Site-specific FSPs are briefly summarized below.

IHSS 115 - Original Landfill. Screening activities at the Original Landfill will consist of a review of the gamma radiation survey recently completed and completion of a soil gas survey and magnetometer survey. Sampling will include subsurface sampling in borings, and sediment and surface water sampling adjacent to the unit. Wells will be installed and sampled downgradient of the unit and in selected soil borings if a plume is encountered. An additional activity at the unit will be a study of the pipes protruding from the landfill and sampling of effluent from the pipes, if present.

IHSS 133.1-6 - Ash Pits 1-4, Incinerator, and Concrete Wash Pad. Aerial photographs will be reviewed to identify the extent of disposal areas at the IHSS sites. A radiological survey and magnetometer survey will be the screening activities conducted at the IHSS 133 sites. Surface soil samples will be collected from the locations that have high radiation concentrations identified during the radiological survey. Subsurface samples will also be collected from borings in the Ash Pit areas. Three monitoring wells will be installed downgradient of the units and sampled.

IHSS 142 - Detention Ponds - C-Series. Surface water samples will be collected from several locations in each pond. Sediment samples will be collected in the ponds, as well as along the entire Woman Creek drainage within the Rocky Flats Plant. Sediment samples will also be collected in the SID. Two monitoring wells will be installed and sampled in the alluvium downgradient of each dam at Ponds C-1 and C-2.

IHSS 209 - Surface Disturbance Southeast of Building 881, the Surface Disturbance West of IHSS 209, and Surface Disturbances South of the Ash Pits. Visual inspections of the surface disturbance areas and reviews of historical use information pertaining to these sites will be completed prior to screening and sampling activities. A radiological survey will be completed at each area. Surface soil samples will be collected from the three excavations at IHSS 209, at the five disturbed areas at the surface disturbance west of IHSS 209, and from the north-south excavation at the surface disturbance south of the Ash Pits. A sediment sample and water sample (if water is present) will be collected from each of the former pond areas at IHSS 209. Surface and subsurface samples will be collected from borings in the parallel excavations and the east and west areas at the surface disturbance south of the Ash Pits. Surface samples will be collected at the surface disturbance west of IHSS 209.

Data collected during the Phase I Woman Creek drainage RFI/RI as well as data from other ongoing and planned investigations will be incorporated into the existing RFEDS database. These data will be used to better define site characteristics, source characteristics, and the nature and extent of contamination; to support the baseline risk assessment and environmental evaluation; and to evaluate potential remedial alternatives. An RFI/RI report will be prepared summarizing the data obtained during the Phase I program and containing the Phase I Baseline Risk Assessment and Environmental Evaluation.

1.0
INTRODUCTION

This document presents the work plan for the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the Woman Creek Drainage (Operable Unit Number 5) at the Rocky Flats Plant, Jefferson County, Colorado. In this work plan, the existing information is initially summarized to characterize Operable Unit Number 5 (OU5) and a field sampling program is presented to assess potential contamination of the ten Individual Hazardous Substance Sites (IHSSs) that have been identified along or within the Woman Creek drainage. These IHSSs include the Original Landfill (IHSS 115), the Ash Pits (IHSS 133.1-133.4), the Incinerator (IHSS 133.5), the Concrete Wash Pad (IHSS 133.6), Detention Ponds C-1 and C-2 (IHSSs 142.10 and 142.11), and Surface Disturbance (IHSS 209). Two additional areas of surface disturbances, one south of the Ash Pits and a second west of IHSS 209, have been included in this OU5 work plan. The Phase I RFI/RI will be conducted in accordance with the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (U.S EPA 1988a) and Interim Final RCRA Facility Investigation (RFI) Guidance (U.S. EPA 1989a). The data generated will be used to begin developing and screening remedial alternatives and to evaluate the need for further studies for the 10 IHSSs in OU5. The data will also be used to estimate the risks to human health and the environment posed by each hazardous substance site.

This investigation is part of a comprehensive, phased program of site characterization, remedial investigations, feasibility studies, and remedial/corrective actions currently in progress at the Rocky Flats Plant. These investigations are pursuant to the U.S. Department of Energy (U.S.DOE) Environmental Restoration (ER) Program [formerly known as the Comprehensive Environmental Assessment and Response Program (CEARP)]; a Compliance Agreement among DOE, the U.S. Environmental Protection Agency (EPA), and the State of Colorado Department of Health (CDH) dated July 31, 1986; and an Interagency Agreement (IAG) among DOE, EPA, and CDH, dated January 22, 1991. The IAG addresses RCRA and CERCLA issues and has been integrated with the ER Program. In accordance with the IAG, the CERCLA terms "Remedial Investigation" and "Feasibility Study" in this document are considered equivalent to the RCRA terms "RCRA Facility Investigation" and "Corrective Measures Study".

1.1 ENVIRONMENTAL RESTORATION PROGRAM

The ER Program is designed to investigate and clean up contaminated sites at DOE facilities. This ER Program being implemented is organized into five major activities. Activity 1 has already been completed at Rocky Flats Plant (U.S. DOE 1986a). This work plan is part of the Activity 2 program currently in progress for OU5 (Woman Creek drainage).

- Activity 1 - Installation Assessment includes preliminary assessments and site inspections to assess potential environmental concerns.

- Activity 2 - Remedial Investigations include planning and implementation of sampling programs to delineate the magnitude and extent of contamination at specific sites, evaluate potential contaminant migration pathways, and perform baseline risk assessments.

- Activity 3 - Feasibility Studies evaluate remedial alternatives and develop remedial action plans to mitigate environmental problems identified as needing correction in Activity 2.

- Activity 4 - Remedial Design/Remedial Action includes design and implementation of site-specific remedial actions selected on the basis of Activity 3 Feasibility Studies.

- Activity 5 - Compliance and Verification implements monitoring and performance assessments of remedial actions and then verifies and documents the adequacy of remedial actions carried out under Activity 4.

The IAG intends that each OU, including OU5, shall proceed through serial phases of investigation dependent on the information gathered to characterize the OU (Section I.B.9, IAG Statement of Work). Pursuant to the final IAG dated January 22, 1991, OUs 3-16 have not undergone Phase I field investigations.

For OU-s 3-16, DOE shall submit draft Phase I RFI/RI Workplans, in accordance with the requirements for RFI/RI Workplans, to EPA and the State for review and comment. DOE shall revise the draft RFI/RI Workplans to address all comments submitted by EPA and the State, and resubmit the RFI/RI workplans to EPA and the State for review and joint written approval.

The results of the Phase I RFI/RI, for OUs 3-16, shall be documented within draft Phase I RFI/RI reports. The draft RFI/RI reports shall include a Preliminary Site Characterization. The draft Phase I RFI/RI reports for OUs 3-16 shall also recommend work to be performed for each Phase II investigation. EPA and the state shall review these draft Phase I RFI/RI reports. DOE will address the comments and resubmit a Final Phase I RFI/RI report for EPA and/or the state review and approval. DOE shall not commence the next investigatory phase prior to receiving approval of the Final Phase I Reports for OUs 3-16 and approval of Phase II RFI/RI Workplans.

The Phase II RFI/RI investigations for OUs 3, 5, 6, 8, 12, 13, 14, 15, and 16 shall be prioritized, scheduled and conducted after evaluation of the Final Phase I RFI/RI Reports. If EPA and/or the state determine that no further investigatory work is required within an OU after the Phase I investigation is complete, EPA and/or the state shall approve the Final Phase I RFI/RI Report as a Final RFI/RI Report for that specific OU. The investigatory phase for each OU within OUs 3-16 shall be considered complete after approval of a Final RFI/RI Report.

1.2 WORK PLAN SCOPE

Existing information on OU5 was obtained from numerous sources for use in work plan preparation. Section 1.0 of this work plan presents introductory information and a general characterization of the region and plant site. In addition, the regional geology and hydrology at Rocky Flats are discussed. Section 2.0 presents descriptions of the site physical characteristics, histories and previous investigations, available information concerning the nature and extent of contamination, and conceptual models for each of the ten IHSSs based on existing data. This initial characterization forms the basis for establishing data needs, data quality objectives (DQOs), and developing an FSP for each IHSS. Section 3.0 presents applicable or relevant and appropriate requirements (ARARs) developed for OU5. Section 4.0 establishes data needs and DQOs considering site characteristics and conceptual models of each IHSS in OU5. Section 5.0 outlines RFI/RI tasks to be performed. Section 6.0 presents the schedule for these tasks. A Field Sampling Plan, based on the requirements of the IAG, is presented in Section 7.0 to satisfy the data needs and DQOs identified in Section 4.0. The Baseline Risk Assessment Plan (BRAP) and Environmental Evaluation Plan (EEP) are presented in Sections 8.0 and 9.0, respectively. A Quality Assurance Addendum (QAA) and Standard Operating Procedure Addenda (SOPA) are presented in Sections 10.0 and 11.0, respectively. A list of references is presented in Section 12.0.

1.3 REGIONAL AND PLANT SITE BACKGROUND INFORMATION

1.3.1 Site Background and Plant Operations

The Rocky Flats Plant is a government-owned and contractor-operated facility that is part of the nationwide nuclear weapons production complex. The Plant was operated for the U.S. Atomic Energy Commission (AEC) from the Plant's inception in 1951 until the AEC was dissolved in January 1975. At that time, responsibility for the Plant was assigned to the Energy Research and Development Administration (ERDA), which was succeeded by the DOE in 1977. Dow Chemical USA, an operating unit of the Dow Chemical Company, was the prime operating contractor of the facility from 1951 until June 30, 1975. Rockwell International succeeded Dow Chemical USA from July 1, 1975 to January 1, 1990, when EG&G Rocky Flats, Inc. succeeded Rockwell International.

The Rocky Flats Plant's primary mission is to produce metal components for nuclear weapons. These components are fabricated from plutonium, uranium and nonradioactive metals, principally beryllium and stainless steel. Parts made at the Plant are shipped elsewhere for final assembly. When nuclear weapons are determined to be obsolete, components of the weapons fabricated at the Plant are returned for special processing to recover plutonium and americium. Other activities at the Rocky Flats Plant include research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics. Both radioactive and nonradioactive wastes are generated in these research and production processes. Current waste handling practices involve on-site and off-site recycling of hazardous materials, on-site storage of hazardous and radioactive mixed wastes, and disposal of solid radioactive materials at another DOE facility. However, historically, Rocky Flats Plant operating procedures included both on-site storage and disposal of hazardous and radioactive wastes. Preliminary assessments under the ER Program identified some of the past on-site storage and disposal locations as potential sources of environmental contamination.

1.3.2 Previous Investigations

Various studies have been conducted at the Rocky Flats Plant to characterize environmental media and to assess the extent of radiological and chemical contaminant releases to the environment. The investigations are referenced in numerous reports including EG&G 1991a.

In 1986, two major investigations were completed at the plant. The first was the ER Program Installation Assessment (U.S. DOE 1986a), which included analyses and identification of current operational activities, active and inactive waste sites, current and past waste management practices, and potential environmental pathways through which contaminants could be transported. A number of sites were identified that could potentially have adverse impacts on the environment. These sites were designated as Solid Waste Management Units (SWMUs) (renamed Individual Hazardous Substance Sites (IHSSs) in the January 22, 1991 IAG) by Rockwell International (1987) and were divided into three categories:

1. Hazardous waste management units that will continue to operate and need a RCRA operating permit.

2. Hazardous waste management units that will be closed under RCRA interim status.

3. Inactive waste management units that will be investigated and cleaned up under Section 3004(u) of RCRA or under CERCLA. No RCRA or CERCLA regulatory distinction in the use of the terms "site," "unit," "SWMU," or "IHSS" is intended in this document.

The second major investigation completed at the Plant in 1986 involved a hydrogeologic and hydrochemical characterization of the entire plant site. Plans for this study were presented in Rockwell International publications 1986b and 1986c, and study results were reported in Rockwell International publication 1986d. These investigations identified the ten IHSSs that are included in OU5 based on their location adjacent to Woman Creek.

1.3.3 Physical Setting

The Rocky Flats Plant is located in northern Jefferson County, Colorado, approximately 16 miles northwest of downtown Denver (Figure 1-1). Other surrounding cities include Boulder, Westminster, and Arvada, which are located less than 10 miles to the northwest, east and southeast, respectively. The plant consists of approximately 6,550 acres of federal land and occupies Sections 1 through 4 and 9 through 15 of T2S, R70W, 6th principal meridian. Major plant buildings are located within a plant security area of approximately 400 acres. The security area is surrounded by a buffer zone of approximately 6,150 acres.

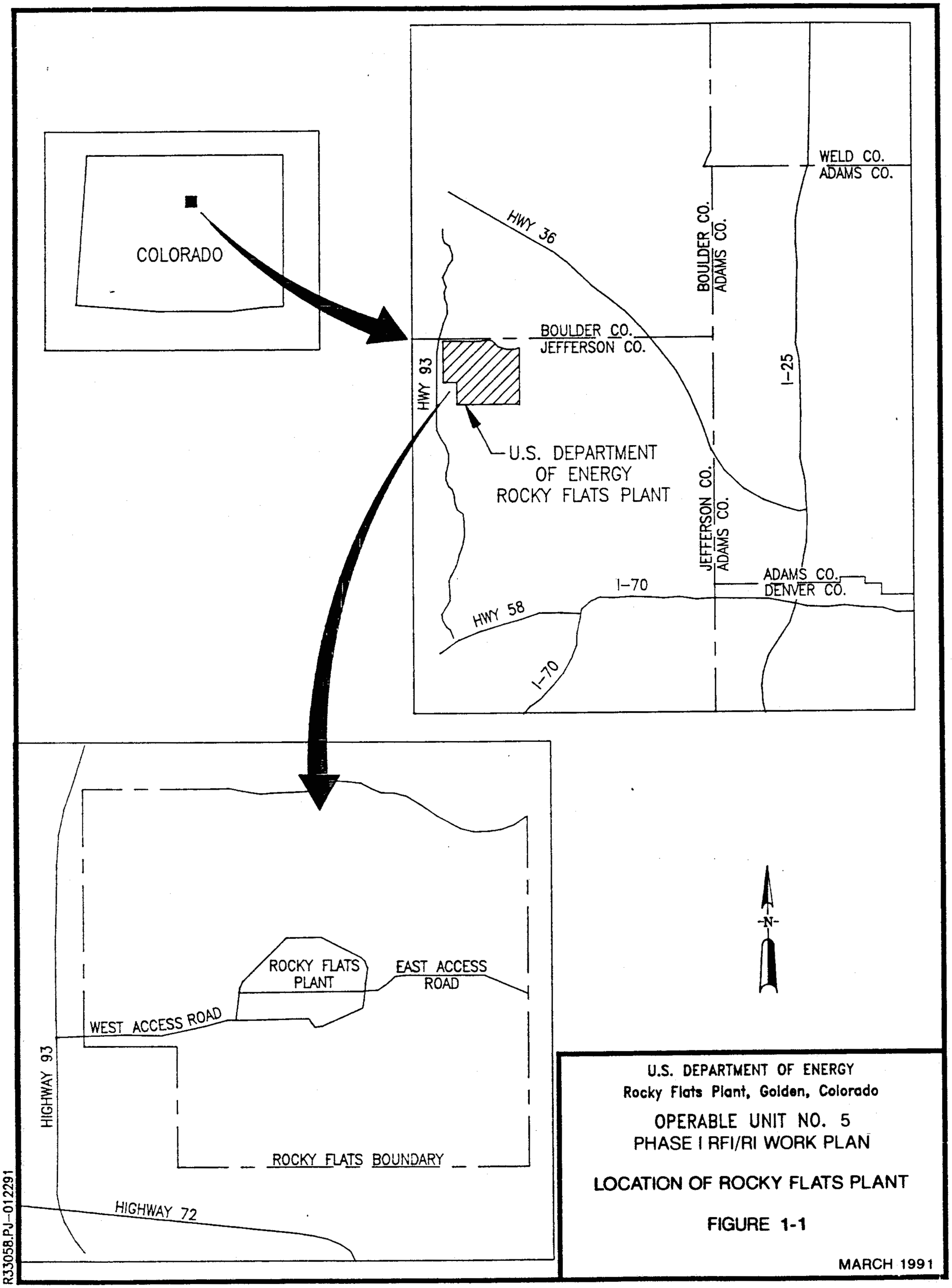
The plant is bounded on the north by Colorado State Highway 128. To the east is Jefferson County Highway 17, also known as Indiana Street; to the south are agricultural and industrial properties and Highway 72; and to the west is Colorado State Highway 93 (Figure 1-2).

1.3.3.1 Topography

The natural environment of the Plant and vicinity is influenced primarily by its proximity to the Front Range of the Rocky Mountains. The plant site is located directly east of the north-south-trending Front Range, located about 16 miles east of the Continental Divide. The Rocky Flats Plant is located on a broad, eastward-sloping system of coalescing alluvial fans. These fans, created by the erosion of the Front Range, extend approximately 5 miles to the east, where they terminate in low, rolling hills. The Plant is at an elevation of approximately 6,000 feet above mean sea level (msl). The Plant security area is located near the eastern edge of the fans on a pediment between stream-cut gullies or arroyos (North Walnut Creek and Woman Creek) (Figure 1-2).

1.3.3.2 Surface Water Hydrology

Three streams drain the Rocky Flats Plant with flow generally from west to east. These drainages are Rock Creek, Walnut Creek, and Woman Creek (Figure 1-2). Rock Creek drains the northwestern corner of the plant and flows northeast through the buffer zone to its off-site confluence with Coal Creek. An east-west trending interfluve separates the Walnut Creek and Woman Creek drainages. North Walnut Creek, South Walnut Creek, and an unnamed tributary drain the northern portion of the Plant security area. These three forks of Walnut Creek join in the buffer zone and flow to Great Western Reservoir, approximately 1 mile east of the confluence. Woman Creek drains the southern Rocky Flats Plant buffer zone, flowing eastward to Standley Lake Reservoir and Mower Reservoir. The South Interceptor Ditch is a ditch that flows intermittently and lies between the Plant and Woman Creek. The South Interceptor



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 5
PHASE I RFI/RI WORK PLAN

LOCATION OF ROCKY FLATS PLANT

FIGURE 1-1

MARCH 1991

Ditch collects runoff from the southern Plant facilities and diverts it to Pond C-2, where it is monitored in accordance with the Plant's National Pollutant Discharge Elimination System (NPDES) permit.

1.3.3.3 Climate

The climate in the area of the Rocky Flats Plant is semi-arid, characterized by warm summers and dry, cool winters, as is typical of much of the central Rocky Mountain Region. However, the elevation of the plant (6,000 feet) and the nearby slopes and canyons of the Front Range modify the regional climate. Winds, although variable, are predominantly from the west-northwest, with stronger winds occurring during the winter. The canyons along the Front Range tend to channel the flow during both upslope and downslope conditions, especially when there is strong atmospheric stability. The area occasionally experiences chinook winds with gusts over 100 miles per hour. Rocky Flats meteorology is strongly influenced by the diurnal cycle of mountain and valley breezes. Two dominant flow patterns exist, one during daytime conditions, and one at night. During daytime hours as the earth heats the mountains receive more direct sunlight than the plains and valleys. The result is a general trend for the air flow to travel toward the higher elevations (upslope). The general air flow pattern during upslope conditions for the Denver area is typically north to south with the flow moving up the South Platte River Valley and then entering the canyons into the Front Range. After sunset the air against the mountain side is cooled and begins to flow toward the lower elevations (downslope). The pattern for the Denver area during downslope is flow moving, down the canyon of the Front Range into the Plains. This flow converges with the South Platte River Valley flow moving toward the north-northeast.

Temperatures at Rocky Flats are moderate. On the average, daily summer maximum temperatures range from 55 to 85 degrees Fahrenheit (°F) and winter maximum temperatures range from 20 to 45° F. Extremely warm or cold weather is usually of short duration. Based on precipitation averages collected between 1953 and 1976, the mean annual precipitation at the plant is approximately 15 inches. Approximately 40 percent of the precipitation falls during the spring, predominantly as wet snow. Autumn and winter are drier seasons, accounting for 19 and 11 percent of the annual precipitation, respectively. Thunderstorms from June to August account for about 30 percent of the total precipitation. Snowfall, generally occurring between October and May, averages 85 inches per year.

1.3.4 Surrounding Land Use and Population Density

The Rocky Flats Plant is located in a rural area. Approximately 50 percent of the area within 10 miles of the Rocky Flats Plant is in Jefferson County. The remainder is located in Boulder County (40 percent) and Adams County (10 percent). According to the 1973 Colorado Land Use Map, 75 percent of this land in 1973 was used for agriculture or was undeveloped. Since 1973, portions of this land have been converted to residential use, with several new housing subdivisions being constructed within a few miles of the buffer zone. One subdivision is located south of Jefferson County Airport, to the northeast, and several are located southeast of the plant (EG&G 1991a).

A recent demographic study shows that approximately 2.2 million people lived within 50 miles of the Rocky Flats Plant in 1989 (U.S. DOE 1990a). Approximately 9,100 people lived within 5 miles of the Plant in 1989. The most populous sector lies to the southeast, toward Denver. Recent population estimates, registered by the Denver Regional Council of Governments (DRCOG) for the eight-county Denver metro region, have shown distinct patterns of growth during the first and second halves of the 1980s. Between 1980 and 1985, the population of the eight-county region increased by 197,890; a 2.4 percent annual growth rate. Between 1985 and 1989, a population gain of 71,575 was recorded, representing a 1.0 percent annual increase (the national average). The 1989 population showed an increase of 2,225 (or 0.1 percent) over 1988 (DRCOG 1989).

There are 8 public schools within 6 miles of the Rocky Flats Plant. The nearest educational facility is Witt Elementary School, approximately 2.7 miles east of the plant buffer zone. The closest hospital is Centennial Peaks Hospital, located approximately 7 miles to the northeast.

The closest park and recreational area is Standley Lake Reservoir, approximately 5 miles southeast of the plant. Boating, picnicking, and limited overnight camping are permitted. Several other small parks exist in communities within 10 miles. The closest major park, Golden Gate Canyon State Park, located approximately 15 miles to the southwest, provides 8,400 acres of general camping and outdoor recreation. Other national and state parks are located in the mountains west of the Rocky Flats Plant, but all are more than 15 miles away.

Some of the land adjacent to the Plant's buffer zone is zoned for industrial development. Industrial facilities within 5 miles include the TOSCO laboratory (a 40-acre site located 2 miles south), the Great Western Inorganics Plant (2 miles south), the Frontier Forest Products yard (2 miles north), the Idealite Lightweight Aggregate Plant (2.4 miles northwest), and the Jefferson County Airport and Industrial Park (a 990-acre site located 4.8 miles northeast). Several ranches are located within 10 miles of the Plant, primarily in Jefferson and Boulder counties. They are operated to produce crops, raise beef cattle, supply milk, and breed and train horses. According to the 1987 Colorado Agricultural Statistics, 20,758 acres of crops were planted in Jefferson County (total land area of approximately 475,000 acres) and 68,760 acres of crops were planted in Boulder County (total land area of 405,760 acres). Crops consisted of winter wheat, corn, barley, dry beans, sugar beets, hay, and oats. Livestock consisted of 5,314 head of cattle, 113 hogs, and 346 sheep in Jefferson County, and 19,578 head of cattle, 2,216 hogs, and 12,133 sheep in Boulder County (Post 1989).

1.3.5 Ecology

A variety of plant life is found within the Plant boundary. Species are representative of lower mountainous and foothill ravine regions and include species of tall and short grass prairie. Riparian vegetation exists along the site's drainages and wetlands. None of the vegetative species present on the Rocky Flats facility have been reported to be on the endangered species list (EG&G 1991a). Previously disturbed areas of the plant have revegetated since establishment of Rocky Flats Plant, as evidenced by the presence of disturbance-sensitive grasses like big bluestem (*Andropogon gerardii*) and sideoats grama (*Bouteloua curtipendula*).

The fauna inhabiting the Rocky Flats Plant and its buffer zone consists of species associated with western prairie regions. The most common large mammal is the mule deer (*Odocoileus hemionus*), with an estimated 100 to 125 permanent residents. There are a number of small carnivores, such as coyote (*Canis latrans*), red fox (*Vulpes fulva*), striped skunk (*Mephitis mephitis*), and long-tailed weasel (*Mustela frenata*). A profusion of small herbivores can be found throughout the Plant and buffer zone, consisting of species such as the pocket gopher (*Thomomys talpoides*), white-tailed jackrabbit (*Lepus townsendii*), and the meadow mole (*Microtus pennsylvanicus*) (U.S. DOE 1980).

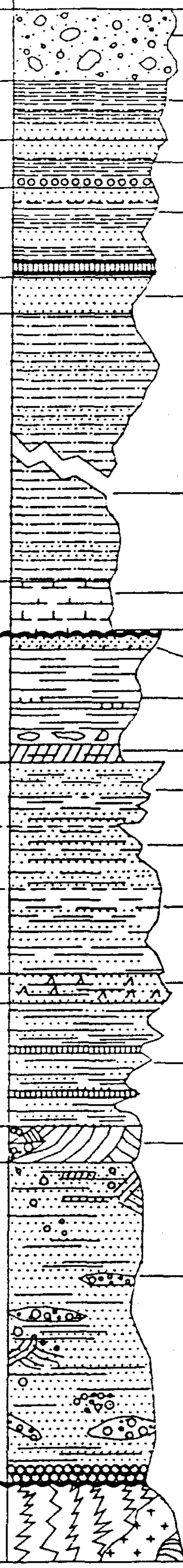
Commonly observed birds include western meadowlarks (*Sturnella neglecta*), horned larks (*Eremophila alpestris*), mourning doves (*Zenaidura macroura*), and vesper sparrows (*Pooecetes gramineus*). A variety of ducks (*Anas sp.*), killdeer (*Charadrius vociferus*), and red-winged blackbirds (*Agelaius phoeniceus*) are seen near pond areas. Mallards (*Anas platyrhynochos*) and other ducks frequently nest and rear young on several of the ponds. Common birds of prey in the area include marsh hawks (*Circus cyaneus*), red-tailed hawks (*Buteo jamaicensis*), ferruginous hawks (*Buteo regalis*), rough-legged hawks (*Buteo lagopus*), and great horned owls (*Bubo virginianus*) (U.S. DOE 1980).

Bull snakes (*Pituophis melanoleucus*) and rattlesnakes (*Crotalus sp.*) are the most frequently observed reptiles. Eastern yellow-bellied racers (*Coluber constrictor flaviventris*) have also been seen. The eastern short-horned lizard (*Phrynosoma douglassi brevirostre*) has been reported on the site, but these and other lizards are not commonly observed. The western painted turtle (*Chrysemys picta*) and the western plains garter snake (*Thamnophis radix*) are found in and around many of the ponds (U.S. DOE 1980).

1.3.6 Regional and Local Hydrogeology

The Rocky Flats Plant is located on a broad, eastward-sloping plain of overlapping alluvial fans along the Front Range of the Rocky Mountains. Figure 1-3 presents a generalized stratigraphic section of the Denver Basin bedrock, and Figure 1-4 shows a local stratigraphic section of the Rocky Flats Plant, including unconsolidated deposits. The surficial geology of the OU5 area is presented in Figure 1-5

AGE	FORMATION	Thickness (feet)	GRAPHICS	SUMMARY DESCRIPTION
TERTIARY	Green Mountain	600'		Boulder conglomerate with occasional thin siltstone lenses
TERTIARY	Denver	870'		Yellowish-brown to grayish-olive fluvial tuffaceous claystone, siltstone, and sandstone interbedded with conglomerate and olive-gray mudflows
UPPER CRETACEOUS	Arapahoe	270'		Yellowish-gray to yellowish-brown sandstone; siltstone; and claystone; discontinuous conglomerate at base
UPPER CRETACEOUS	Laramie	500'		Gray, fine-to-medium-grained sandstone and silty clays; thin coal beds in lower part
UPPER CRETACEOUS	Fox Hills	60'		Tan, fine-to-medium-grained sandstone and sandy shale
UPPER CRETACEOUS	Pierre	± 8000'		Dark gray, silty shale and few thin, silty sandstones
UPPER CRETACEOUS	Niobrara	350'		Dark gray, very calcareous shale. "Foraminifers" abundant (Smoky Hills Member) Light gray, dense, fossiliferous limestone (Fort Hays Member)
UPPER CRETACEOUS	Benton	420'		Brown, sandy, fossiliferous limestone Dark gray shale with bentonite streaks; thin limestones in middle part; few cone-in-cone concretions in lower part Dark gray, brittle silty shale (Mowry)
LOWER CRETACEOUS	Dakota Group: So. Platte	270'		Light gray, fine-to-medium-grained sandstone, several dark gray shales in middle part
LOWER CRETACEOUS	Dakota Group: Lytle	100'		Light gray, fine-to-coarse-grained, locally conglomeratic sandstone; frequent red and green siltstone interbeds
Jurassic	Morrison	365'		Gray to greenish-gray to red shale and siltstone; thin limestones in middle part; lenticular sandstones in upper and lower part
Jurassic	Ralston Creek	110'		Light tan siltstone and light red; silty shale; gypsiferous; sandstone at base and locally conglomeratic
TRI-ASSIC?	Lykins	400'		Red siltstone with two laminated limestones in lower part
PERMIAN	Lyons	120'		Grayish-white, fine-to-medium-grained cross-bedded sandstone; conglomeratic lenses frequent
PENNSYLVANIAN	Fountain	1000'		Red, fine-to-coarse-grained sandstone and conglomerate; arkosic; thin, lenticular red siltstones frequent throughout
PRECAMBRIAN				Gneiss, schist, and small granite intrusions



(modified from: Weimer, 1973)

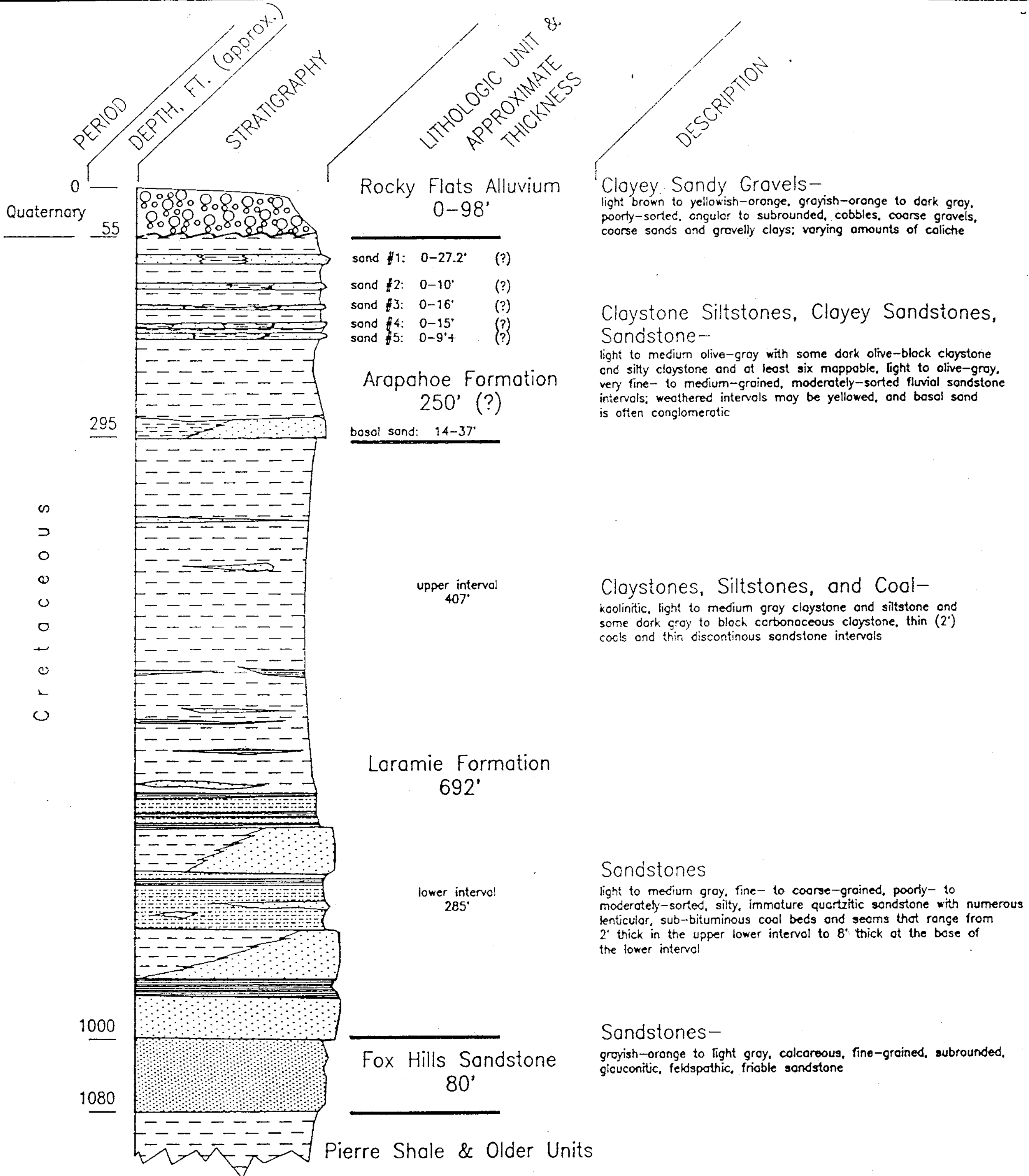
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 5
PHASE I RFI/RI WORK PLAN

GENERALIZED STRATIGRAPHIC SECTION OF THE DENVER BASIN BEDROCK

Figure 1-3

MARCH 1991



EXPLANATION

	Alluvium		Coal
	Fine-grained & coarser sandstone		Fine-grained sandstone
	Siltstone and claystone		Silty sandstone

(?) Query indicates preliminary interpretation and incomplete data.

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT NO. 5
PHASE I RFI/RI WORK PLAN

LOCAL STRATIGRAPHIC SECTION
OF THE ROCKY FLATS PLANT

FIGURE 1-4 REV. AUGUST 1991
MARCH 1991

R33151.PJ-080791

(EG&G 1990c). Groundwater occurs under unconfined conditions in both the surficial units and the shallow bedrock units. In addition, groundwater occurs in deeper bedrock sandstones under confined conditions. A description of each of the geologic units is discussed in the following subsections.

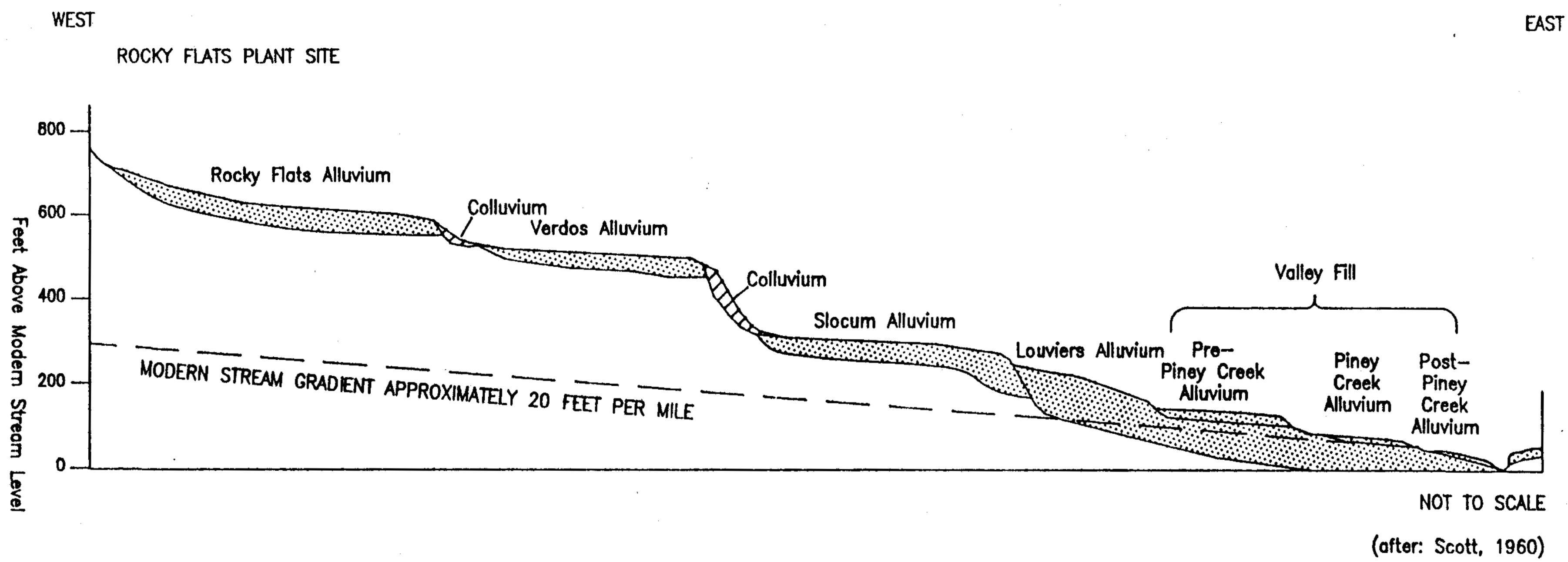
1.3.6.1 <u>Rocky Flats Alluvium</u>

The Rocky Flats Alluvium is the oldest and topographically highest alluvial deposit in the Rocky Flats Plant area (Figure 1-6). The Rocky Flats Alluvium was deposited by braided streams that produced a series of coalescing alluvial fans. The alluvium is a broad deposit consisting of a topsoil layer underlain by up to 100 feet of varying amounts of silt, clay, and gravel. Unconfined groundwater flow occurs in the Rocky Flats Alluvium, which is relatively permeable. Recharge to the alluvium is from precipitation, snowmelt, and water losses from ditches, streams, and ponds that are cut into the alluvium. General water movement in the Rocky Flats Alluvium is from west to east and toward the drainages. Groundwater flow is also controlled by pediment drainages in the top of the bedrock. Groundwater levels in the Rocky Flats Alluvium rise in response to recharge in the spring and decline in the summer, fall, and winter. Fluctuations in the groundwater level vary approximately 2 to 25 feet within the Plant site vicinity (Hurr 1976). Discharge from the alluvium occurs at seeps in the colluvium that covers the contact between alluvium and underlying bedrock along the edges of the valleys. Most seeps flow intermittently. The Rocky Flats Alluvium thins and discontinues east of the Plant boundary and, therefore, does not directly supply water to wells located downgradient of the Rocky Flats Plant.

1.3.6.2 <u>Other Alluvial and Colluvial Deposits</u>

Various other alluvial deposits occur topographically below and east of the Rocky Flats Alluvium in the drainages of the Rocky Flats Plant. Colluvium (slope wash) mantles the valley side slopes between the Rocky Flats Alluvium and the valley bottoms. The colluvium is a product of mass wasting that collects on the sides and at the base of hills and slopes. These deposits tend to be poorly sorted mixtures of soil debris from bedrock clay and sand, mixed with gravel and cobbles derived from the older alluvium which caps the hills and ridges (Hurr 1976). The colluvium varies from a few inches to several feet in thickness and rests on bedrock and other alluvial material. In addition to the colluvium, remnants of younger terrace deposits including the Verdos, Slocum, and Louviers alluvial deposits occur occasionally along the valley side slopes. Recent valley fill alluvium occurs in the active stream channels.

Unconfined groundwater flow occurs in these surficial deposits. Recharge occurs through precipitation, infiltration from streams during periods of surface water runoff, and by seeps discharging from the Rocky Flats Alluvium. Discharge occurs through evapotranspiration and by seepage into other geologic formations, subcrops, and streams. The direction of groundwater flow is generally to the east and downslope through colluvial materials, and then along the course of the stream in valley fill materials.



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OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

EROSIONAL SURFACES AND ALLUVIAL DEPOSITS EAST OF THE FRONT RANGE, COLORADO

FIGURE 1-6 MARCH 1991

During periods of high surface water flow, some of the water is lost to bank storage in the valley fill alluvium and then returns to the stream after the runoff subsides.

1.3.6.3 Arapahoe Formation

Underlying most of the surficial units at the Rocky Flats Plant is the Cretaceous Arapahoe Formation. The Arapahoe Formation is a fluvial deposit consisting primarily of siltstones and claystones, with some silty sandstones beneath the plant. Geologic characterization of the Arapahoe Formation beneath Rocky Flats indicates fluvial channel sequences containing sandstones occur in stream channel-shaped structures. Arapahoe Formation thickness varies but maximum thickness is approximately 270 feet (Robson et al. 1981a), and the unit is nearly horizontal beneath the plant (less than 2° dip) (EG&G 1990g and 1990e). The channel-shaped fluvial sequences within the claystone are composed predominately of fine-grained sands and silts, and their hydraulic conductivity is equivalent to or less than that of the overlying Rocky Flats Alluvium. The Arapahoe Formation described by earlier RFI/RI studies contains more clay and silt than typically described for other areas within the Denver Basin. There is a similarity of the siltstones and claystones beneath Rocky Flats of those of the Laramie Formation.

The Arapahoe Formation is recharged by groundwater from overlying surficial deposits and infiltration from streams. The main recharge areas are under the Rocky Flats Alluvium although limited recharge from the colluvium and valley fill alluvium likely occurs along the stream valleys (U.S. DOE 1990a). Recharge is greatest during the spring and early summer, when rainfall and stream flow are at a maximum and water levels in the Rocky Flats Alluvium are high. Groundwater movement on a regional basis is from west to east, in the Arapahoe Formation, although the groundwater flow regime in the bedrock has generally not yet been characterized. Regionally, groundwater flow in the Arapahoe Formation is toward the South Platte River in the center of the Denver Basin (Robson et al. 1981a).

1.3.6.4 Laramie Formation and Fox Hills Sandstone

The Laramie Formation underlies the Arapahoe Formation and is composed of a thick upper claystone unit and lower sandstone unit and coal interval. The Laramie Formation is approximately 700 feet thick. The upper claystone interval is approximately 400 feet thick and is of very low hydraulic conductivity; therefore, the U.S. Geological Survey (Hurr 1976) concluded that Plant operations will not impact any units below the upper claystone unit of the Laramie Formation.

The lower sandstone unit of the Laramie Formation and the underlying Fox Hills Sandstone form a regionally important aquifer in the Denver Basin known as the Laramie-Fox Hills Aquifer. Near the center of the basin, the aquifer thickness ranges from 200 to 300 feet. West of the plant, the Laramie-Fox Hills Aquifer can be seen in clay pits excavated through the Rocky Flats Alluvium. The steeply dipping beds of these units west of the plant (approximately a 50° dip) quickly flatten to the east (less than 2° dip) (EG&G 1990g and 1990e). Recharge to this aquifer occurs along the rather limited outcrop area exposed to surface water flow and infiltration along the Front Range (Robson et al. 1981b).

1.4 RECENT GEOLOGIC CHARACTERIZATION

EG&G identified inconsistencies in the methods that had been used for logging geologic materials and interpreting geologic data at Rocky Flats. As a result, a project was initiated to develop a geologic characterization of the Rocky Flats Plant by conducting a literature review, reclassifying previously obtained samples using standardized procedures, conducting further laboratory testing on previously obtained samples, processing seismic data, and then reinterpreting the geology based on all available data.

Interim results of this ongoing study are presented in a draft report (EG&G 1990b). However, that report is a working draft which has not been prepared for distribution. That report presents summaries of stratigraphy and structural geology of the area and regions, the current working model of Plant geology, conclusions based on the working model, and recommendations for further work required to continue the ongoing characterization. Data and summaries of the data pertinent to OU5 are presented in this Work Plan.

2.0
PRELIMINARY SITE CHARACTERIZATION

Ten Individual Hazardous Substance Sites (IHSSs), geographically located along or within the drainage areas of Woman Creek (Figure 2-1), have been designated as Operable Unit 5 (OU5). These IHSSs are identified in the Environmental Restoration Interagency Agreement (IAG), dated January 22, 1991, as the Original Landfill (IHSS 115), Ash Pits, Incinerator area, and Concrete Wash Pad (IHSSs 133.1 through 133.6), Detention Ponds C-1 and C-2 (IHSSs 142.10 and 142.11), and a Surface Disturbance (IHSS 209). Ponds C-1 and C-2 are the only IHSSs located on Woman Creek. The remaining eight IHSSs are located along the banks and/or upland areas that drain into Woman Creek or into the South Interceptor Ditch (SID). In addition to these ten IHSSs, two additional surface disturbances will be investigated in the Phase I OU5 investigation, a surface disturbance west of IHSS 209 and a surface disturbance south of the Ash Pits (133).

The initial step in the development of the OU5 work plan was a review of existing information. Available historical and background data for each IHSS were collected through a literature search, which included references at the Rocky Flats Public Reading Room and various libraries within the Rocky Flats Plant, and a review of the RFEDS. Information concerning existing alluvial and bedrock groundwater monitoring wells within the Woman Creek drainage have been collected for this work plan (Table 2-1). Personal communications with plant personnel were also used as a source of information during the background data review so that each IHSS could be better described.

The ten IHSSs are discussed in detail in the following subsections. The location and description of each IHSS, the history of use, surface drainage, nature of contamination, previous investigations conducted at or near the individual IHSSs, geology, and hydrology are discussed. The Ash Pits, Incinerator, and Concrete Wash Pad are grouped together in the following discussions, as are Ponds C-1 and C-2, since these units have interrelated and similar histories. The areal extent and boundary of each IHSS is based on a preliminary review of historical aerial photographs (U.S. EPA 1988b) and the historical operations of the unit. The boundaries for each IHSS in this work plan are the same as those established in the IAG except for the Original Landfill (IHSS 115) and the Surface Disturbance (IHSS 209). The southern boundary of the Original Landfill has been extended approximately 300 feet toward the south across the SID based on a site reconnaissance. The Surface Disturbance boundary was extended to the north and southwest based on a site reconnaissance and aerial photographs. Several investigations are ongoing within the Woman Creek drainage, including surface water, groundwater and sediment sampling and investigations at OUs 1 and 2. Where previous or ongoing investigations have been conducted at or near an IHSS, some of the analytical data are included for reference in the following sections. The inclusion of these data is for informational purposes only. No conclusions are made in this work plan regarding the presence or absence of contamination based on these data. The geology underlying

TABLE 2-1

ALLUVIAL AND BEDROCK GROUNDWATER WELLS IN THE VICINITY OF OPERABLE UNIT NO. 5

Well Number	Status	Ground Surface Elevation	Total Depth (feet)	Formation Completed In	Depth to Bedrock	Screened Interval
B402689	1	6045.40	5.85	Qvf	2.80	2.55-3.28
1474	2	5993.30	5.74	--		
5686	1	5977.16	9.60	--	7.0	2.60-9.60
5786	1	5950.77	6.75	Qvf	6.0	2.50-6.50
7086	1	5929.79	7.90	Qvf	7.0	2.36-7.90
0481	2	5944.30	5.41	--		
P416889	3,4	6017.4	21.52	Qrf	20.20	15.86-20.27
P416789	3,4	6027.80	28.20	Qrf	26.40	22.48-26.90
P416589	3,4	6041.20	32.10	Qrf	30.50	27.04-31.0
P416489	3,4	6048.50	26.98	Qrf	25.20	21.27-25.70
P416389	4	6055.40	31.40	Qrf	29.80	25.69-30.10
B405289	1	5965.60	48.0	Kss(u)	10.30	41.24-45.67
B405189	1	5967.90	24.45	Kcl	8.20	13.20-22.69
B405889	1	6024.90	46.75	Kss(w)	6.50	36.04-45.50
B402189	1,3	6024.60	24.60	Kss(w)	7.50	13.5-22.90
B405989	1	6023.50	8.50	Qc	6.20	2.80-6.70
B401989	1,3	6025.60	22.65	Qc	20.50	6.55-21.00
B302089	1,3	5907.50	15.0	Qc	13.50	3.85-13.30
5886	1	5888.89	3.50	Qvf	3.0	1.50-3.50
B301889	1,3	5866.80	24.45	Qc	22.30	13.16-22.60
B304789	1	5867.50	39.14	Kcl	22.90	27.90-37.57
6486	1	5834.48	9.0	Qvf	8.80	3.41-9.0
6586	1	5782.75	8.0	Qvf	7.10	2.50-8.0
1674	1	5767.50	5.41	--		
2987	1	5812.42	20.50	Qc	19.80	3.50-20.30
6386	1	5900.40	15.50	Qc	14.80	3.80-15.25

TABLE 2-1
(Continued)

ALLUVIAL AND BEDROCK GROUNDWATER WELLS IN THE VICINITY OF OPERABLE UNIT NO. 5

Well Number	Status	Ground Surface Elevation	Total Depth (feet)	Formation Completed In	Depth to Bedrock	Screened Interval
4787	1	5882.72	7.50	Qc	7.0	3.50-7.25
4887	1	5909.94	10.30	Qc	9.80	3.50-10.05
0487	1	5909.79	19.70	Qc	19.50	3.51-19.47
0287	1	5930.56	9.32	Qc	8.75	3.22-9.08
6986	1	5921.19	14.0	Qc	13.30	3.0-14.0
0887BR	1	5919.70	89.34	Kss(u)	8.70	84.0-89.02
5986BR	1	5919.90	28.60	Qc	29.50	20.10-27.30
5986	2	5914.32	28.0	Kss(w)	7.50	19.0-28.0
0387BR	1	5930.58	108.0	Kss(u)	20.0	102.80-107.75
B410689	1	6091.70	51.33	Qrf	0.0	30.5-50.05
B410589	1	6111.80	61.31	Qrf	0.0	40.55-60.04
5386	1	6053.20	7.80	Qvf	7.0	2.5-7.8
B405586	1	6103.62	36.39	Qrf	35.50	3.55-36.39
B405489	1	6115.80	50.05	Kcl	34.0	39.13-48.57
6886	1	5880.75	3.50	Qvf	2.8	1.5-3.50
P314289	3,4	6010.10	14.80	Qrf	13.0	9.11-13.51
0187	1	5992.35	12.08	Qaf	11.87	3.38-11.83
5287	1	5967.60	20.50	Qrf	20.0	3.50-20.25
5187	1	5963.30	14.08	Qrf	13.50	3.58-13.84
5387	1	5959.82	9.30	Qc	8.80	3.50-9.05
5487	1	5955.85	4.68	Qaf/Qc	4.20	1.33-4.53
5587	1	5858.08	7.50	Qt	7.0	3.35-7.35
1074	1	5925.40	9.96	--	--	--
4387	1	5924.92	12.50	Qc	12.0	3.50-12.25
4987	1	5912.68	5.0	Qc	4.5	1.80-4.75

TABLE 2-1
(Concluded)

ALLUVIAL AND BEDROCK GROUNDWATER WELLS IN THE VICINITY OF OPERABLE UNIT NO. 5

Well Number	Status	Ground Surface Elevation	Total Depth (feet)	Formation Completed In	Depth to Bedrock	Screened Interval
0687	1	5904.53	7.06	Qc	6.5	3.56-6.88
5087	1	5933.21	13.70	Qc	13.20	3.50-13.50
4487	1	5949.53	3.70	Qc	3.20	1.50-3.50
4587BR	1	5949.42	101.30	Kss	4.0	89.50-101.05
6686	1	5685.12	6.5	Qvf	5.80	2.5-6.5
0186	1	5619.14	10.20	Qvf	9.90	3.19-8.84
5486	1	6103.39	85.25	Kss(u)	36.0	75.43-85.24
0857	1	5927.76	51.50	Kss(u)	12.20	42.0-51.25
3087	1	5811.87	94.35	Kss(u)	16.0	85.79-94.35
1487	1	5855.0	24.30	Kss(w)	5.20	19.0-24.05
6286	1	5897.54	35.19	Kss(w)	22.0	25.22-35.19
B416689	3,4	6035.0	33.76	Qrf	32.0	28.09-32.50

Source (EG&G 1990d)

NOTES:

Key to Well Number:
- Prefix P - 1989 well within plant security area
- Prefix B - 1989 well in the Buffer Zone
- Suffix BR - Bedrock well prior to 1989

Key to Status:
- 1 - Active
- 2 - Inactive
- 3 - Borehole Sampled
- 4 - Observation Well

Key to Geologic Strata:
- Qaf - Artificial fill
- Qvf - Valley fill alluvium
- Qrf - Rocky flats alluvium
- Qc - Colluvium
- Kcl - Bedrock Claystone
- Kss(u) - Bedrock unweathered sandstone
- Kss(w) - Bedrock weathered sandstone

each IHSS has been characterized by the ongoing geologic characterization program in progress by EG&G at Rocky Flats (EG&G 1990b). This program includes conducting a comprehensive literature search, reprocessing and describing previously obtained core samples, reprocessing previously obtained seismic data, and collecting and analyzing selected sample for grain size analyses. The geologic characterization program will incorporate all geologic information Plant-wide for continued refinement of the working geologic model. The referenced report is a draft internal working document. Data and results of this characterization that are pertinent to Operable Unit 5 are presented in this work plan. In addition to the review of each IHSS, a generic conceptual model for the IHSSs of OU5 has been developed. The generic model will be refined and modified appropriate to each IHSS in the RFI/RI Report.

Also discussed in the following section is the Woman Creek drainage system adjacent to the plant site. Woman Creek is the drainage system that provides a common physical setting for all the IHSSs in OU5.

2.1 WOMAN CREEK AND DIVERSION STRUCTURES

The Rocky Flats Plant is geographically located on a plateau and is bounded on the south by the Woman Creek drainage (Figure 2-1). Woman Creek flows from west to east through the Rocky Flats facility and into Standley Lake Reservoir and Mower Reservoir about 1½ miles from the facility's eastern boundary (Figure 1-2). Woman Creek originates near Coal Creek approximately 1½ miles to the west of Highway 93. Near the west boundary of the plant facility, within the buffer zones, Woman Creek crosses under the South Boulder diversion canal. The canal cross over is constructed of wood and presently contributes water to Woman Creek due to leakage. Other waters which enter into Woman Creek within the buffer zone include upstream runoff and water released from the Rocky Flats Lake. Water is released from Rocky Flats Lakes into Woman Creek by a local rancher as part of his water rights agreement. This flow is diverted out of Woman Creek to Mower Reservoir below Pond C-2.

The natural drainage of Woman Creek has been somewhat modified in the OU5 area by the construction of Ponds C-1 (IHSS 142.10) and C-2 (IHSS 142.11) and the SID south of the plant site. Currently, Woman Creek flows eastward through OU5 in its natural stream channel to Detention Pond C-1 (IHSS 142.10) (Figure 2-1). The purpose of Detention Pond C-1 is for stormwater management and for sampling and monitoring of the water upstream in Woman Creek. Water is rarely retained within this pond as the outlet or gate is usually open and the water is allowed to flow through the pond. The water consequently flows in its natural channel until just west of Pond C-2 where it is diverted around Pond C-2 by a diversion canal. Downgradient and to the east of Pond C-2, approximately two thirds of the water is diverted from Woman Creek's main channel into an unnamed ditch to Mower Reservoir. The remaining flow continues to flow downstream in Woman Creek and into Standley Lake Reservoir.

In 1980, the SID was constructed upslope (to the north) of Woman Creek (Figure 2-1). The SID was built to intercept surface runoff from the plant site. A berm was constructed on the downslope side of the SID to contain the water flowing in this ditch. Since construction of the SID in 1980, Woman Creek has not received runoff directly from the southern part of the plant facility. Surface water flow in the SID is intermittent and usually occurs only following precipitation events or snow melt. When flow is low, water tends to pond in several areas of the ditch. The SID begins approximately 200 feet east of the Ash Pits and runs for almost two miles to Detention Pond C-2 (IHSS 412.11) (Figure 2-1). The SID is approximately four to eight feet in depth and is not lined. Just upslope of Pond C-2, the water flowing in the SID crosses over Woman Creek and flows into Detention Pond C-2. As-built drawings for Pond C-2 are presented in Appendix A of this work plan. In Pond C-2, the water is sampled, analyzed and discharged according to a National Pollutant Discharge Elimination System (NPDES) agreement (Permit Number CO-0001333). The purpose of the NPDES is to achieve and maintain compliance with water pollution control standards of the Clean Water Act at Rocky Flats. Discharge limitations and parameters monitored under this NPDES permit are summarized in the Surface Water Management Plan at Rocky Flats (U.S. DOE 1991). The water discharged from Pond C-2 was treated by an activated carbon treatment system for a period of time, due to high concentrations of atrazine (U.S. EPA 1991) and was pumped via pipeline to the Broomfield Diversion Ditch, which carries the water around Great Western Reservoir into Big Dry Creek. Discharges were also routed through a pipeline from Pond B-5 to Pond A-4 for treatment (Figure 1-2) (U.S. DOE 1991). Prior to the construction of these pipelines, surface water from Pond C-2 was discharged to Woman Creek.

Currently new plans are underway to pump the water from Pond C-2 to the cooling tower water supply system. A brief description of this program is presented below. The water from Pond C-2 will be pumped through a filtration system (the primary purpose of this system is for algae control and to collect suspended solids) and then pumped to the holding tanks at the water treatment plant. Prior to pumping the water from Pond C-2, the water will be sampled and analyzed. In the event that chemical contamination is detected, a portable treatment system (i.e. activated carbon treatment system) will be installed or the water will be pumped through the existing diversion system at the site to Pond B-5 and Pond A-4 (Figure 1-2). From the holding tanks at the water treatment plant, the water will be pumped into the raw water distribution system-downstream of the backflow preventers. Once the water enters into the raw water system, it will be sent to the cooling tower water supply system.

The Woman Creek drainage is included in the Plant-wide Radioactive Ambient Air Monitoring Program (EG&G 1991b). Seven stations currently exist in the Woman Creek drainage area, and three additional stations are proposed in OU5. These existing and proposed monitoring stations are shown on Figure 2-1.

2.2 ORIGINAL LANDFILL (IHSS 115)

2.2.1 Location and Description

The Original Landfill is located within the buffer zone just south of the Rocky Flats Plant security area and south of the west access road (Figure 2-2). It is located north of Woman Creek on a moderately to steeply sloping south-facing hillside. The boundary of the landfill has been determined principally from historic aerial photographs and from the operational history of this unit. For the purpose of this work plan, the southern boundary of this IHSS has been extended farther south, as field investigations conducted by EPA and CDH identified the presence of wastes south of the SID and just north of Woman Creek in some areas. The landfill and its preliminary extension are approximately 330,000 square feet (7.5 acres) (Figure 2-2). Elevations of this IHSS range from about 5,940 feet to 6,050 feet.

2.2.2 History

The Original Landfill was in operation from 1952 to 1968 and was used to dispose of general wastes generated at the Rocky Flats Plant. It is estimated that 2 million cubic feet of miscellaneous Plant wastes are buried in the landfill, including such things as solvents, paints, paint thinners, oil, pesticides, and cleaners (Rockwell 1988). These wastes were not considered hazardous prior to 1968, when they were placed in the landfill. The landfill also received beryllium and/or uranium wastes and may originally have been used as a graphite dump. It is reported that ash containing an estimated 20 kilograms (kg) of depleted uranium (U.S. DOE 1986b), produced when 60 kg of depleted uranium were inadvertently burned and only 40 kg was recovered, was buried within the landfill. Small quantities of various other chemicals are also believed to be buried within the landfill (Rockwell 1988). In a previous report, several sealed drums were reported to have been present on the north side of the landfill based on an interpretation of a 1969 aerial photograph (Rockwell 1988). In 1978, the surface over the entire landfill appeared very hummocky. A letter, dated August 23, 1979, from Rockwell International to DOE, stated that hot spots containing depleted uranium were uncovered in the landfill. All hot spots were removed from the landfill in one box of soil during July 1979 (Rockwell 1979). By 1980 the SID had been built across the southern part of the landfill.

An evaporation/settling pond that was used for backflushing sand filters from the water treatment facility (Building 124), was located approximately 25 feet southwest of the present surface water location SW-37(Rockwell 1988) (Figure 2-2). It appears that a second pond was visible in a 1955 aerial photograph in the approximate location of the SID, but by 1964 this pond was no longer present and the area had been covered by fill. Several other activities at the landfill are apparent from aerial photographs of the area (U.S. EPA 1988b). A surface disturbance area east of the landfill was active in the 1964 aerial photograph (Figure 2-2). Little documented historical information is available concerning this area;

however, this area may have served as a storage yard for pipes and scrap metal. In addition, soil appears to have been placed in this area as substantial mounds of debris are noted in this area in the 1969 and 1971 aerial photographs (U.S. EPA 1988b).

The landfill was closed with a soil cover; however, a bottom liner was not installed. Details of the construction of the surface cover are not available, nor is the year the cover was installed. A few years ago, the slope on the south side of the landfill was regraded to correct sloughing and erosion-related problems. The surface of the landfill is currently hummocky and irregular.

Two 3-foot-diameter corrugated metal pipes protrude from the landfill (Figure 2-2). No flow was observed from these pipes during several site visits in 1990. The west pipe appears to be connected to an abandoned storm drain constructed with 15-inch vitrified clay pipe (Rockwell 1988). The pipe to the east is reported to be connected to a 36-inch reinforced concrete pipe, which is connected to the footing drains of Building 460 and possibly several drainage pipes on the plant site (U.S. DOE 1987). Currently, the surface outfall of this pipe does not appear to be connected to a drainage pipe. In July 1986, after a major rainstorm, seepage began emerging from the Original Landfill (U.S. DOE 1987). This seepage was subsequently traced to the eastern-most pipe. The SID was enlarged shortly after the seepage was recognized. During a site visit in February 1988, water was heard flowing within this eastern pipe (Rockwell 1988). In addition, a berm structure was constructed south of the SID to prevent surface runoff from crossing the SID during a major storm event. A containment embankment was constructed near the eastern-most outfall pipe to stabilize the irregular and hummocky surface that existed at the landfill; however, details of this construction are not available.

2.2.3 Surface Drainage

The upslope area that drains across the Original Landfill (IHSS 115) is small with downslope flow coming principally from south of the west access road (200 feet to the north of the Original Landfill). Surface runoff across IHSS 115, therefore, is minimal, with runoff from this IHSS flowing downslope to the south where it empties into the SID (Figure 2-2). The moderate to steep slope of the landfill typically results in relatively rapid flow of surface water across this unit and limits the amount of ponding that occurs. The SID is located approximately 300 feet upslope of Woman Creek and collects almost all of the surface runoff from the landfill (Figure 2-2). Water in the SID flows eastward to Detention Pond C-2 (IHSS 142.11) approximately 1½ miles to the east (IHSS 142.11, Section 2.4).

2.2.4 Nature of Contamination and Previous Investigations

Chemicals that may have been placed in this landfill include commonly used solvents, such as trichloroethylene, carbon tetrachloride, tetrachloroethylene, petroleum distillates, 1,1,1-trichloroethane, dichloromethane, benzene, paint and paint thinners. Metals such as beryllium, uranium, lead, and chromium may also be present (Rockwell 1988). Accurate records of any further wastes placed in this landfill are not available.

An in situ radiological survey using a 20% N-type, high germanium gamma ray detector was conducted over the Old Landfill from October 25 through December 8, 1990 (EG&G 1991e). The data collected indicated that most detected radioisotopes present were consistent with natural background. However, there was evidence of soil disturbance and there were areas of elevated concentrations of uranium-238. The results of this survey are contained in Appendix B of this report.

To provide some background data for this area, chemical analytical results from two groundwater monitoring wells (7086 and 5786) installed in 1986 were reviewed. These wells are located downgradient of the landfill and just north of Woman Creek (Figure 2-1). A summation of the analytical results of several sampling events between 1987 and 1991 is presented in Appendix C. Analytes detected above the Contract Required Quantitation Limit (CRQL) in wells 7086 and 5786 have been tabulated and are presented in Tables 2-2 and 2-3, respectively. Common laboratory contaminants (i.e., acetone, methylene chloride) were not listed as potential hits on Tables 2-2 and 2-3, unless they had concentrations greater than 5 times the CRQL. This is consistent with the Statement of Work in USEPA Contract Laboratory Guidance (USEPA 1988e). These analytical results were obtained from RFEDS.

2.2.5 Geology and Hydrology

The geology near the Original Landfill has been characterized from the information obtained from nearby monitoring wells and by the general knowledge of the geologic setting of the Rocky Flats site. Six groundwater monitoring wells (0481, 7086, 5786, B416689, P416589, and P416489) have been installed near the Original Landfill (Figure 2-2). However, there are no wells within IHSS 115, so specific data on the geology and hydrogeology beneath the landfill are lacking.

A north-to-south cross section through the Original Landfill area is shown in Figure 2-3. The three geologic units that are present beneath the Original Landfill are colluvium, Rocky Flats Alluvium, and the Arapahoe Formation. The nature and thickness of these formations beneath the landfill area are unknown as the nearby monitoring wells are located on the plateau above the Original Landfill or along the Woman Creek drainage. The erosion and depositional processes in these two areas are different from the sloping area where the Original Landfill is located. Therefore, the thickness and depth of these formations beneath the landfill can only be estimated. In the following subsections each of the three formations present (colluvium, Rocky Flats Alluvium, and Arapahoe Formation) and the hydrogeology near the landfill are discussed.

TABLE 2-2

MAXIMUM HITS ABOVE CRQLs
IN GROUNDWATER SAMPLES COLLECTED FROM WELL 7086

Analyte	Total Samples	Total CRQL Hits	CRQL	Maximum Hit
Dissolved Metals (μg/l)				
Barium	16	1	200.0	223.3
Beryllium	16	2	5.0	14.0
Calcium	16	16	5,000.0	64,126.7
Copper	16	2	25.0	38.0
Iron	16	6	100.0	1,100.0
Lead	15	1	5.0	14.0
Magnesium	16	12	5,000.0	14,100.0
Manganese	16	10	15.0	872.0
Mercury	15	2	0.2	0.6
Nickel	16	1	40.0	162.0
Potassium	15	5	5,000.0	10,300.0
Sodium	16	16	5,000.0	42,487.4
Strontium	16	15	200.0	732.4
Zinc	16	5	20.0	40.1
Total Radionuclides (pCi/l)				
Gross Alpha	4	3	2.0	80.0
Gross Beta	4	4	2.0	90.0
Plutonium 238	1	1	0.00	0.009095 J
Plutonium 239	3	1	0.01	0.12
Strontium 90	2	2	1.00	5.55
Uranium (Total)	3	3	0.00	22.0
Uranium 233/234	3	1	0.60	12.0
Uranium 238	3	3	0.60	10.0
Dissolved Radionuclides (pCi/l)				
Americium 241	8	2	0.01	0.74
Gross Alpha	12	5	2.00	21.0
Gross Beta	12	9	2.00	24.0
Plutonium 239	8	1	0.01	0.02

TABLE 2-2
(Concluded)

Analyte	Total Samples	Total CRQL Hits	CRQL	Maximum Hit
Strontium 90	4	1	1.00	3.4
Uranium (Total)	6	6	0.00	1.03
Uranium 233/234	9	1	0.60	0.6623
Uranium 238	9	1	0.60	0.7

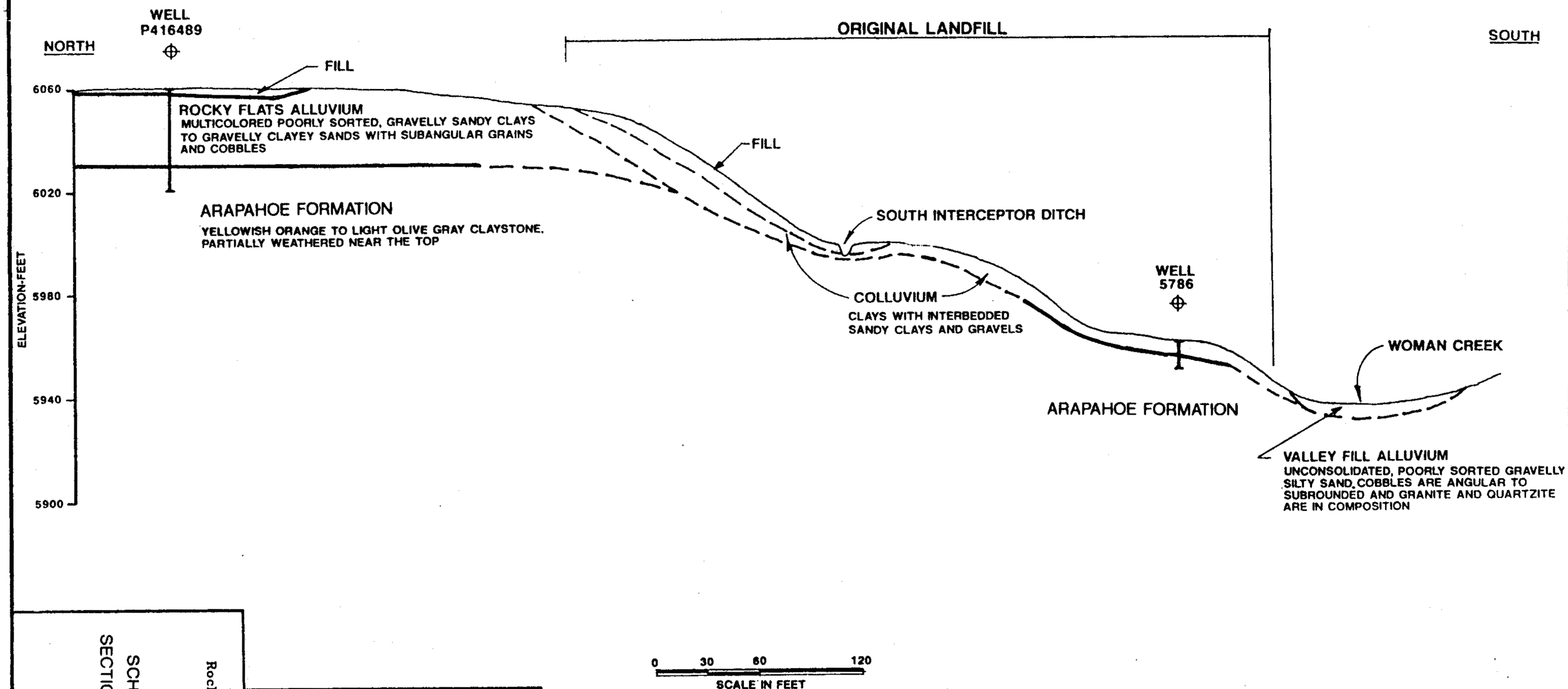
J = present below detection limit

TABLE 2-3

MAXIMUM HITS ABOVE CRQLs IN GROUNDWATER SAMPLES COLLECTED FROM WELL 5786

Analyte	Total Samples	Total CRQL Hits	CRQL	Maximum Hit
Dissolved Metals (μg/l)				
Aluminum	4	1	200.0	1352.0
Calcium	4	4	5,000.0	97,600.0
Iron	4	3	100.0	4,650.0
Lead	4	1	5.0	87.0
Magnesium	4	4	5,000.0	31,100.0
Manganese	4	4	15.0	799.0
Nickel	4	1	40.0	336.4
Silicon	2	2	100.0	9,140.0
Sodium	4	4	5,000.0	59,000.0
Strontium	4	4	200.0	666.0
Zinc	4	1	20.0	34.2
Total Radionuclides (pCi/l)				
Americium 241	2	1	0.01	0.07176
Gross Alpha	1	1	2.0	27.0
Gross Beta	1	1	2.0	48.0
Plutonium 238	1	1	0.00	0.002269 J
Plutonium 239/249	1	1	0.01	0.02171
Uranium (Total)	1	1	0.00	14.42
Uranium 233/234	1	1	0.60	8.7
Uranium 238	1	1	0.60	5.3
Dissolved Radionuclides (pCi/l)				
Gross Alpha	2	2	2.00	8.0
Gross Beta	2	2	2.00	8.451
Uranium 233/234	2	2	0.60	8.3
Uranium 238	2	2	0.60	5.8

J = present below detection limit



EXPLANATION

⌖ ALLUVIAL MONITORING WELL

--- INFERRED BOUNDARY OF GEOLOGIC UNITS

VERTICAL EXAGGERATION 1.5X

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

SCHEMATIC GEOLOGICAL CROSS SECTION ACROSS ORIGINAL LANDFILL

Figure 2-3

MARCH 1991

Colluvium

Colluvial deposits are thought to exist beneath the Original Landfill based on their presence on similar sloping areas of the Rocky Flats facility. The colluvium is typically deposited by slope wash and downslope creep of the Rocky Flats Alluvium and/or the Arapahoe Formation. These deposits tend to be poorly sorted mixtures of soil and debris from bedrock clay and sand, mixed with gravel and cobbles of the alluvium. The thickness of colluvium beneath the landfill is unknown but the colluvium and the Rocky Flats Alluvium are likely to be less than 25 feet thick. A combined thickness isopach map of the colluvium and Rocky Flats Alluvium is shown in Figure 2-4.

Rocky Flats Alluvium

The Rocky Flats Alluvium consists of multicolored poorly sorted gravelly sandy clays to gravelly clayey sands with subangular grains and scattered cobbles. This unit is the oldest and topographically highest alluvial deposit at the Rocky Flats Plant. The Rocky Flats Alluvium unconformably overlies all the older bedrock formations. The Alluvium generally slopes to the east (Hurr 1976).

The thickness of the Rocky Flats Alluvium below the Original Landfill is unknown; however, this unit is likely to be approximately 20 to 25 feet thick based on the thickness of the Rocky Flats Alluvium in monitoring wells P416489 and P416589 north of the landfill.

Arapahoe Formation

The Arapahoe Formation encountered in wells adjacent to the Original Landfill is a fairly uniform yellowish-orange to light olive-gray claystone that is weathered near its top. The depth to this formation in the vicinity of the Original Landfill varies, but generally becomes shallower to the south toward Woman Creek drainage. In nearby wells, the Arapahoe Formation has been encountered from 6 to 30 feet below the ground surface.

Hydrogeology of the Original Landfill

The uppermost aquifer beneath the landfill is likely to be colluvium and possibly Rocky Flats Alluvium. The groundwater level is probably between 10 to 20 feet below the ground surface in this area and under unconfined conditions. Fluctuations in the groundwater level occur on a seasonal basis (Rockwell 1988).

The hydraulic gradient in the colluvium and Rocky Flats Alluvium aquifer beneath the Landfill is to the southeast (Figure 2-5). This groundwater gradient is principally controlled by the erosional surface of the underlying Arapahoe Formation. Generally, in steeply sloping areas of the site, such as the area of the Landfill, the groundwater in the Rocky Flat Alluvium and colluvium flows downslope along the fairly impermeable surface of the underlying Arapahoe Formation until it reaches Woman Creek. At Woman Creek the hydraulic gradient changes to the east and parallels the Woman Creek drainage.

The lithology of the Arapahoe Formation beneath the landfill, if similar to the lithology encountered in upgradient and downgradient wells near the landfill, is a claystone. Groundwater in the overlying alluvium is thus not expected to migrate significantly downward into the Arapahoe Formation. However, within the uppermost section of the Arapahoe Formation, as observed at several locations beneath the Plant Site, subcropping sandstones have been encountered. Further characterization of the lithologic nature of the bedrock beneath this IHSS, is therefore, needed.

2.3 ASH PITS 1-4 (IHSSs 133.1, 133.2, 133.3, 133.4), INCINERATOR (IHSS 133.5), AND CONCRETE WASH PAD (IHSS 133.6)

There are six IHSSs discussed together in the following subsections (four Ash Pits, the Incinerator and the Concrete Wash Pad). These six IHSSs have been grouped together because of their proximity to each other and interrelated histories.

2.3.1 Location and Description

The Incinerator, Ash Pits, and Concrete Wash Pad are located south-southwest of the main security area of the Rocky Flats Plant, south of the west access road and north of Woman Creek (Figure 2-6). The locations of these IHSSs are defined from historic aerial photographs. The Incinerator, which had a 10- to 20-foot stack, was located along the plant's original west boundary, off the west access road. The Ash Pits are located to the east, and Concrete Wash Pad to the southwest of the Incinerator. Ash Pits 1, 2, 3, and 4 (IHSSs 133.1, 133.2, 133.3, and 133.4) are approximately 8 feet wide by 150 feet long and 3 feet deep. However, these Ash Pits may be larger as the exact boundaries and dimensions of each unit are somewhat undefined (U.S. DOE 1987). The four Ash Pits are located on a relatively flat surface and are currently covered by tall grasses (Figure 2-6).

The Incinerator area (IHSS 133.5) occupies approximately 4,000 square feet and the Concrete Wash Pad (IHSS 133.6) covers an area of about 33,000 square feet. These two IHSSs are located west of the four Ash Pits. The Concrete Wash Pad has an extremely irregular hummocky surface that slopes gently to the south toward Woman Creek.

The distance from these IHSSs to Woman Creek varies from about 25 feet to 630 feet with the Concrete Wash Pad being the closest to Woman Creek (Figure 2-6). A steep slope is present just north of the Ash Pits and the incinerator area. A dirt road crosses Ash Pit 3 (IHSS 133.3).

2.3.2 History

The Incinerator (IHSS 133.5) was used to burn general plant wastes between the 1950s and 1968. Depleted uranium is also believed to have been burned in the incinerator (Rockwell 1988). A review of aerial photographs revealed that the Incinerator was removed by 1971 and the entire area was beginning to revegetate (U.S. EPA 1988b). Ashes from the Incinerator were placed into the Ash Pits (IHSSs 133.1 through 133.4) or were pushed over the side of the hill into the Woman Creek drainage and/or onto the Concrete Wash Pad (IHSS 133.6) (Rockwell 1988). Following the shutdown of the Incinerator after 1968, the Ash Pits were covered with fill (Rockwell 1988); however, information about the material used in the construction of the cover is unavailable.

The history of the Concrete Wash Pad has not been as well documented as the Ash Pits or Incinerator area. It appears that this area was used to dispose of waste concrete from the concrete trucks involved in the construction activities of the plant facility. It is also likely that the concrete trucks were washed down in this area after delivering concrete.

2.3.3 Surface Drainage

A steep slope is present north of these six IHSSs and surface runoff from these units is toward the south. The upslope area that contributes runoff to these IHSSs is not very large since drainage north of the access road is intercepted by the drainage ditch along the road. Consequently, only a small amount of runoff crosses these units (Figure 2-6). The soils which cover these IHSSs probably limit contact of surface water with the materials that may be present. The surface runoff from these IHSSs flows into Woman Creek to the south. The SID originates approximately 200 feet east of these IHSSs and therefore does not divert any of the runoff coming from these units. The runoff from these IHSSs, after draining into Woman Creek, flows into Pond C-1 (IHSS 142.10). The water is sampled and analyzed from this pond on a monthly basis; however, the water is usually not detained within the pond but allowed to flow downstream into Woman Creek.

2.3.4 Nature of Contamination and Previous Investigations

The history of the Ash Pits, Incinerator area, and Concrete Wash Pad is not entirely known because few records were kept of their operations. It is, known, however, that general combustible wastes from the Rocky Flats plants facility were burned in the Incinerator along with an estimated 100 grams of depleted uranium (Owen 1973). The ashes from the Incinerator were disposed in the Ash Pits. At the Concrete

Wash Pad Area (IHSS 133.6), potentially contaminated materials consist of concrete debris and occasional ashes from the Incinerator that were reported to have been pushed over the side of the hill onto the Concrete Wash Pad area (Rockwell 1988).

A rayscope survey was conducted over Ash Pit 3 (IHSS 133.3) prior to 1973 and the results of this survey detected metals (type unknown) (U.S. DOE 1987). No documentation exists as to whether the other ash pits (IHSSs 133.1, 133.2, and 133.4) had a rayscope survey done over their surfaces.

Analytical results from groundwater samples collected from a monitoring well 5686 (installed in 1986) are included in this Work Plan to provide some groundwater quality data for this area. This well is located downslope of the ash pits and just north of Woman Creek (Figure 2-1). Analytical results of several sampling events between 1987 and the first half of 1991 are summarized in Appendix C. Analytes detected above the CRQL are tabulated and presented in Table 2-4. Chemical analytical results for groundwater from monitoring well B410589 are also included in summary form in Appendix C. This well was installed in 1989 and is located upgradient from the Ash Pits (IHSS 133) (Figure 2-1). Analytes detected above the CRQL are presented in Table 2-5. Common laboratory contaminants (i.e., acetone, methylene chloride) were not listed as potential hits on Tables 2-4 and 2-5 unless they had concentrations greater than 5 times the CRQL. This is consistent with the Statement of Work in USEPA Contract Laboratory Guidance (USEPA 1988). These data were obtained from the RFEDS.

2.3.5 Geology and Hydrology

The geology near and beneath the Ash Pits and Incinerator area (IHSSs 133.1 through 133.5) is likely to be similar to the geology that underlies the Original Landfill, located 500 feet to the east and on the same sloping hillside (see Subsection 2.2.5). The geologic units present in this area include the colluvium, Rocky Flats Alluvium, and the Arapahoe Formation. For a detailed lithologic description of each of these rock units, see subsection 2.2.5. The thickness of these geologic units near this area is unknown since the three closest monitoring wells (1474, 5686, and B402689) have been drilled within the Woman Creek drainage itself and thus encountered somewhat different geologic conditions. However, the colluvium and Rocky Flats Alluvium have been estimated to be less than 20 feet in this area based on an isopach map of the colluvium and Rocky Flats Alluvium in the vicinity of the Original Landfill (Figure 2-4).

The geology below the Concrete Wash Pad may be slightly different than the Ash Pits and Incinerator area since this unit is closer to the Woman Creek drainage. The geology within the Woman Creek drainage consists of approximately 2 to 8 feet of valley fill alluvium overlying the Arapahoe Formation. Valley fill alluvium a few feet thick was encountered in well B402689, located approximately 1,000 feet upgradient (west) of the Concrete Wash Pad within the Woman Creek drainage area. The valley fill

TABLE 2-4

MAXIMUM HITS ABOVE CRQLs
IN GROUNDWATER SAMPLES COLLECTED FROM WELL 5686

Analyte	Total Samples	Total CRQL Hits	CRQL	Maximum Hit
Pesticide/PCB (μg/l)				
Hexavalent Chromium	1	1	0.00	160,000.0
Dissolved Metals (μg/l)				
Aluminum	17	1	200.0	331.6
Arsenic	16	1	10.0	14.1 J
Calcium	17	17	5,000.0	31,074.9
Chromium	17	1	10.0	25.7
Copper	17	1	25.0	28.2
Iron	17	5	100.0	697.3
Lead	16	2	5.0	18.0
Magnesium	17	15	5,000.0	7,430.0
Manganese	17	7	15.0	340.0
Nickel	17	1	40.0	426.5
Silicon	2	2	100.0	6,600.0
Sodium	17	17	5,000.0	24,700.0
Zinc	17	8	20.0	73.6
Total Radionuclides (pCi/l)				
Gross Alpha	4	3	2.0	23.0
Gross Beta	4	3	2.0	32.0
Plutonium 238	2	1	0.00	0.02013
Plutonium 239	3	2	0.01	0.28
Plutonium 239/240	2	1	0.01	0.05173
Strontium 90	2	2	1.00	4.01
Uranium (Total)	3	2	0.00	3.0
Uranium 233/234	3	1	0.60	1.5
Uranium 238	3	2	0.60	1.5
Dissolved Radionuclides (pCi/l)				
Americium 241	6	2	0.01	0.09
Gross Alpha	13	3	2.00	10.0

TABLE 2-4
(Concluded)

Analyte	Total Samples	Total CRQL Hits	CRQL	Maximum Hit
Gross Beta	13	10	2.00	88.0
Plutonium 239	8	1	0.01	0.04
Strontium 90	3	1	1.00	1.3
Uranium (Total)	8	7	0.00	1.7
Uranium 233/234	9	1	0.60	0.8

J - present below the detection limit

TABLE 2-5

MAXIMUM HITS ABOVE CRQLs
IN GROUNDWATER SAMPLES COLLECTED FROM WELL B410589

Analyte	Total Samples	Total CRQL Hits	CRQL	Maximum Hit
Volatiles (μg/l)				
Acetone		1	10.0	31.0 B
Pesticide/PCB (μg/l)				
Parathion, Ethyl	1	1	0	10.0
Total Metals				
Calcium	1	1	5,000.0	40,100.0
Chromium	1	1	10.0	13.4
Magnesium	1	1	5,000.0	10,400.0
Silicon	1	1	100.0	9,030.0
Silver	1	1	10.0	12.0
Sodium	1	1	5,000.0	10,900.0
Strontium	1	1	200.0	244.0
Dissolved Metals (pCi/l)				
Aluminum	3	1	200.0	828.0 E
Cadmium	3	1	5.0	26.3
Calcium	3	3	5,000.0	39,500.0
Iron	3	1	100.0	556.0
Lead	3	1	5.0	103.0
Magnesium	3	3	5,000.0	10,100.0
Manganese	3	2	15.0	537.0
Sodium	3	3	5,000.0	11,000.0
Strontium	3	3	200.0	236.0
Total Radionuclides (pCi/l)				
Plutonium 238	1	1	0.00	0.0004679
Dissolved Radionuclides (pCi/l)				
Gross Alpha	3	1	2.00	8.2
Gross Beta	3	2	2.00	10.8
Plutonium 239	1	1	0.01	0.017
Uranium 233/234	3	3	0.60	1.974
Uranium 238	3	2	0.60	1.084

E - Estimated Value

alluvium in this well is described as an unconsolidated dark brown gravel. The Arapahoe Formation is a grayish-orange slightly silty claystone, that is calcareous. Beneath the northern part of the Concrete Wash Pad, colluvium/Rocky Flats Alluvium may exist because this area is close to the sloping hillside where these units are present.

There are no wells immediately adjacent to or on IHSSs 133.1 through 133.6, so specific hydrogeologic data beneath this area is lacking. Based on the lithology of wells in the vicinity, however, it is estimated that the uppermost aquifer underlying these IHSSs is the colluvium/Rocky Flats Alluvium and valley fill alluvium. Groundwater occurs 4 to 8 feet below ground surface (Rockwell 1988). Groundwater flow direction near these IHSSs is probably toward the Woman Creek drainage. Adjacent to Woman Creek, the flow direction changes to the east, similar to the Woman Creek flow direction (Figure 2-5). The Arapahoe Formation which underlies these surficial units has not been characterized in this area. Therefore, the lithology of the Arapahoe Formation would need to be determined to evaluate possible hydraulic communication, if any, between the bedrock and uppermost aquifer.

2.4 PONDS C-1 AND C-2 (IHSSs 142.10 AND 142.11)

2.4.1 Location and Description

Ponds C-1 (IHSS 142.10) and C-2 (IHSS 142.11) are located along Woman Creek, southeast of the main security area of the Rocky Flats Plant and within the Buffer Zone (Figure 2-7). These ponds are approximately 2,000 feet apart, with Pond C-1 to the west of Pond C-2. The estimated capacities for Ponds C-1 and C-2 are approximately 750,000 gallons and 22,480,000 gallons, respectively. The as-built plans for Pond C-2 are in Appendix A (EG&G 1991c). No as-built drawings exist for Pond C-1. A description of how these ponds interact with the Woman Creek surface water flow is contained in Section 2.1.

2.4.2 History

The C-series Detention Ponds are used primarily to capture and control surface water runoff from the plant's facilities and from Woman Creek. Filter backwash water from the water treatment facility was discharged to Pond C-1 (IHSS 142.10) between plant start-up in 1952 and December 21, 1973 (U.S. DOE 1980). In addition, the cooling tower blowdown water was discharged to Pond C-1 until the latter part of 1974. In the early 1970s, the plant operations were changed and Pond C-1 was used principally to manage the surface water runoff in the Woman Creek drainage.

Pond C-2 (IHSS 142.11) was constructed in 1980 to detain runoff water from the SID (see Section 2.1). The water in Pond C-2 is monitored monthly and discharged periodically. The discharged water is treated by an activated carbon treatment facility and pumped via pipeline toward Great Western

Reservoir, where the water is diverted around this Reservoir by the Broomfield Diversion Ditch. The Broomfield Diversion Ditch empties into Big Dry Creek. The discharge from Pond C-2 is regulated by an NPDES permit (Permit Number CO-0001333). The last time Pond C-2 was discharged was in June 1990. Currently, the pond (as of January 1, 1991) is about 25 percent full, containing approximately 5.7 million gallons.

2.4.3 Surface Drainage

The surface drainage system into Detention Ponds C-1 and C-2 has already been discussed in Section 2.1. Detention Pond C-1 receives surface water from Woman Creek with little runoff received from the plant site. Pond C-2 receives the runoff from the southern plant facilities via the SID.

2.4.4 Nature of Contamination and Previous Investigations

Several studies have been conducted pertaining to the analyses of water and sediment samples from Detention Ponds C-1, C-2, and along Woman Creek drainage. Included in these studies was a 1970 study conducted by the EPA (U.S. EPA 1970), a 1980 study by D. Paine on plutonium in freshwater systems at Rocky Flats (Paine 1980), and a 1986 study conducted as a requirement for a RCRA Part B - Operating Application (U.S. DOE 1986c). In addition, analytical results from surface water samples collected in Ponds C-1 and C-2 and at the existing sampling locations along Woman Creek have been summarized as part of this work plan.

The study conducted in February 1970 involved the analyses of radionuclides in a water sample and bottom sediment sample collected in Woman Creek near Indiana Street (U.S. EPA 1970). Bottom sediment samples were collected by scraping the bottom area below the water line with a hand trowel. Grab samples of water were collected in 1-gallon plastic containers with 2 to 5 gallons collected per sample. Radionuclides detected in the water samples included gross alpha (0.9 pCi/l), Sr-89 (0.5 pCi/l), Sr-90 (0.4 pCi/l), total alpha radium (<0.1 pCi/l), and uranium (2.2 μg/l). No analyses were done for tritium. Radionuclides detected in the bottom sediment included gross alpha (9.0 pCi/gram dry weight), total alpha radium (4.8 pCi/gram dry weight), plutonium-239 (0.23 pCi/grams dry weight), and uranium (1.5 μg/g) (U.S. EPA 1970).

The 1980 study by D. Paine was conducted in order to determine the behavior of plutonium in the freshwater systems at Rocky Flats (Paine 1980). In this study, sediment cores were taken at 5-cm intervals on a monthly basis from Pond C-1 during the study period (spring of 1971 through the summer of 1973). These core samples were taken to determine the vertical distribution of plutonium in the pond sediments. Surface water samples and water samples were collected at 0.5-meter increments from the pond surface to the sediment/water interface.

The average or mean plutonium concentrations (Pu-239 and Pu-240) in unfiltered water and surface sediments taken from Pond C-1 during this study period is illustrated in Figure 2-8. The sediment samples collected at depth showed no significant vertical variation in plutonium concentrations with depth, probably because of the shallow nature of Pond C-1. In addition, the plutonium concentrations detected in the pond sediments of Pond C-1 are relatively low in comparison to Ponds B-1, B-2, B-3, B-4 and A-1. This may be due to the relatively low percentage of plutonium in the filterable fraction of the water samples (Table 2-6). In this 1980 study, Paine concluded that sediments (especially clays) appear to be the major reservoir for ultimate plutonium deposition and that relatively insignificant transport of plutonium through biotic systems to man exist.

The 1986 study "Trends in the Rocky Flats Surface Water Monitoring" summarized analytical data collected between 1980 and 1985 (U.S. DOE 1986a). Maximum plutonium concentrations measured in the surface water of Pond C-2 during this period were 0.05 pCi/l. Maximum concentrations for uranium and americium at the NPDES designated discharge point below Pond C-2 were 2.8 pCi/l and 0.02 pCi/l, respectively. For Pond C-2, the maximum tritium concentrations detected were 1200 pCi/l. Nitrate concentrations remained nearly constant in Pond C-2 throughout the five-year period and the pH in Pond C-2 ranged between 8.0 and 8.5 (Rockwell 1988). Sediment samples were not collected in Ponds C-1 or C-2 for this study.

<u>Existing Sediment Sampling Program</u>

Sediment samples have been collected quarterly at 18 sampling locations along Woman Creek, the SID, and other tributaries to Woman Creek (Figure 2-1) over the last several years, with the majority of the samples collected since 1989. This existing sediment sampling program consists of three sample locations upstream of OU5 (SED-16, SED-15, and SED-127), two sample locations downgradient of the Ash Pits (SED-17 and SED-39), two sample locations south of Woman Creek, from a seep, and on an unnamed tributary to Woman Creek (SED-18 and SED-19), six sediment sample locations along the SID (SED-126, SED-28, SED-31, SED-29, SED-30, and SED-25), one sediment sample location between ponds C-1 and C-2 (SED-26), and three sediment sample locations downstream from Pond C-2 (SED-24, SED-1, and SED-2). Sediment samples are collected from each of these locations according to Rocky Flats SOP SW.6, with the samples analyzed for TAL metals, TCL-volatiles, TCL semi-volatiles, TCL pesticides/PCBs, and radionuclides.

The existing sediment analytical data from this site-wide sampling program have been reviewed and summarized in several tables. Table 2-7 presents the analytical program for each location and the number of samples that have been analyzed for each of the analyte groups. Most of the sampling locations have been sampled one to four times over the last several years. In Appendix D (Table 1), the number of sediment samples from all 18 locations which had reported concentrations above the CRQL limits for each analyte have been compiled with the maximum concentrations and average

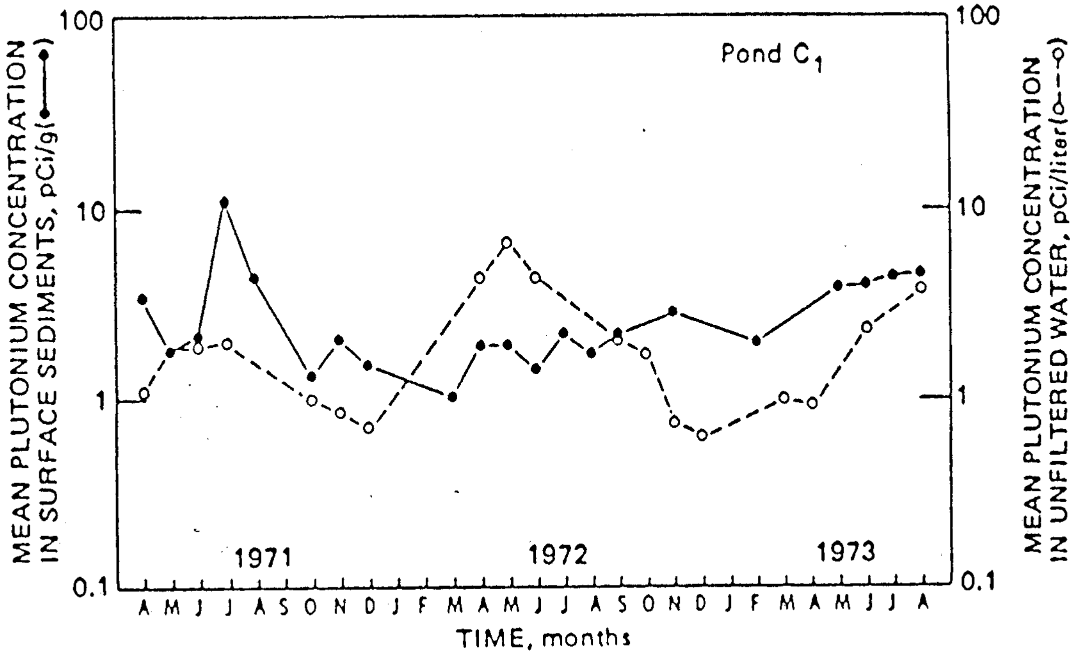


FIGURE 2-8 Mean plutonium concentrations in surface sediments (pCi/g) and mean plutonium concentrations in unfiltered water (pCi/l) for Pond C-1.

Source: Paine 1980

TABLE 2-6

PERCENT OF PLUTONIUM ISOTOPES ASSOCIATED WITH FILTERABLE FRACTION OF WATER SAMPLES FROM ROCKY FLATS PONDS

Pond	Filterable Fraction*
B-1	90 ± 6
B-2	80 ± 12
B-3	80 ± 8
B-4	70 ± 12
C-1	30 ± 30
A-1	35 ± 20

* Mean ± standard error

Source: Paine 1980

TABLE 2-7

SUMMARY OF SITE ANALYSES FOR SEDIMENTS

Site Location	Historical Analyses	Sample Location	No. of Sample Events	Summary of Hits	Phase
SED 127	VOA	Upgradient	2		Two
	B/N	of OU-5	2	B/N	
	Acids		2		
	Pest/PCB		2		
	Rads++		2	Rads	
	Metals		2	Metals	
SED 015	VOA	Woman Creek	1		One
	Pest/PCB	- Just East	1		
	Rads	of Hwy 93	1	Rads	
	Metals		1	Metals	
SED 016	VOA	Woman Creek	2	VOA+	Two
	B/N	- Upgradient	2	B/N*	
	Acids	of Concrete	2		
	Pest/PCB	Wash Pad	2		
	Rads		2	Rads	
	Metals		3	Metals	
SED 017	VOA	Woman Creek-	2	VOA+	Two
	B/N	Downgradient	2	B/N*	
	Acids	of Ash Pit	2		
	Pest/PCB		2		
	Rads		2	Rads	
	Metals		3	Metals	
SED 014	VOA	Woman Creek -	1	VOA+	One
	B/N	downgradient	2	B/N	
	Acids	of ash pits	1		
	Pest/PCB		1		
	Rads		1	Rads	
	Metals		1	Metals	

TABLE 2-7
(Continued)

Site Location	Historical Analyses	Sample Location	No. of Sample Events	Summary of Hits	Phase
SED 018	VOA	Unnamed	1	VOA+	Two
	B/N	Tributary-	2	B/N*	
	Acids	Downgradient	2		
	Pest/PCB	of Surface	2		
	Rads	Disturbance	2	Rads	
	Metals		3	Metals	
SED 019	VOA	Unnamed	1	VOA+	One
	B/N	Tributary	1		
	Acids		1	Acid	
	Pest/PCB		1		
	Rads		2	Rads	
	Metals		2	Metals	
SED 126	VOA	SID-Between	2		Two
	B/N	Landfill and	2	B/N*	
	Acids	C-1	2		
	Pest/PCB		2		
	Rads+•		2	Rads	
	Metals		2	Metals	
SED 027	VOA	Woman	4	VOA+	Two
	B/N	Creek-	2	B/N	
	Acids	Downgradient	2		
	Pest/PCB	of C-1 Pond	3		
	Rads		1	Rads	
	Metals		3	Metals	
SED 028	VOA	SID - North	2	VOA+	One
	B/N	of C-1	1		
	Acids		1		
	Pest/PCB		2		
	Rads		1	Rads	
	Metals		3	Metals	

TABLE 2-7
(Continued)

Site Location	Historical Analyses	Sample Location	No. of Sample Events	Summary of Hits	Phase
SED 031	VOA	SID-Between	1	VOA	One
	Metals	C-1 and C-2	1	Metals	
	Rads++		1		
SED 029	VOA	Woman Creek	3	VOA	Two
	B/N	- Between C-1	2	B/N*	
	Acids	and C-2	2		
	Pest/PCB		2		
	Rads		2	Rads	
	Metals		3	Metals	
SED 030	VOA	SID -	4	VOA	Two
	B/N	Between	1	B/N	
	Acids	C-1 and C-2	1		
	Pest/PCB		2		
	Rads		3	Rads	
	Metals		3	Metals	
SED 026	VOA	Woman Creek	3	VOA+	Two
	B/N	- Between	2		
	Acids	C-1 and C-2	2		
	Pest/PCB		2		
	Rads		2	Rads	
	Metals		2	Metals	
SED 025	VOA	Woman Creek	3	VOA+	Two
	B/N	- North of	2	B/N*	
	Acids	C-2 Pond	2		
	Pest/PCB		2		
	Rads		2	Rads	
	Metals		2	Metals	

TABLE 2-7
(Concluded)

Site Location	Historical Analyses	Sample Location	No. of Sample Events	Summary of Hits	Phase
SED 024	VOA	Woman Creek	3		Two
	B/N	Creek -	2		
	Acids	Downgradient	2		
	Pest/PCB	of C-2 Pond	2		
	Rads		2	Rads	
	Metals		2	Metals	
SED 001	VOA	Woman Creek	3	VOA+	Two
	Base-Neutral	at Indiana	4	B/N*	
	Acids	Street	4		
	Pest/PCB		3		
	Rads		4	Rads	
	Metals		2	Metals	
SED 002	VOA	Unnamed	3		Two
	Base-Neutral	Ditch and	3	B/N*	
	Acids	Indiana St.	3		
	Pest/PCB		3		
	Rads		2	Rads	
	Metals		3	Metals	

*	Bis(2-ethylhexyl) Phthalate(s) - Common laboratory contaminant.
+	Common Laboratory Contaminants measured at greater than 5 times CRQL.
++	Rads analyzed but sampling results are not yet available.
VOA	Volatile organic analysis
B/N	Base/Neutral extractable organics
Acid	Acid extractable organics
Pest/PCB	Pesticides/Polychlorinated biphenyl
Rads	Radionuclides

detectable concentrations provided. These data are further summarized for each sediment location in Appendix D (Table 2), which lists the reported concentrations for all analytes above the CRQL (except for metals), along with their analyte groups. Metals were not included on this table because of their variable concentrations and because background sediment concentrations have not been established. In Appendix D (Table 2), four organic compounds, acetone, methylene chloride, toluene, and 2-butanone (common laboratory contaminants), are not listed unless their concentrations are greater than 5 times the CRQL, as is recommended in the Scope of Work for the USEPA Contract Laboratory Program (USEPA 1988e). In addition, reported concentrations of bis (2-ethylhexyl) phthalate are footnoted as being a common laboratory contaminant.

Based on these sediment data, several observations about the distribution of contaminants within the sediments of OU5 are apparent. For pesticides/PCBs, no detectable concentrations are reported from the 36 samples analyzed at these locations (Appendix D). This suggests that pesticides are probably not present in Woman Creek, and that there is a reduced need to analyze for these contaminants in the OU5 sediments.

For the organic sediment data, there appears to be very few organic concentrations above the CRQL (Table 2-7). Figure 2-9 graphically presents the organic concentrations above the CRQL, excluding common laboratory contaminants acetone and methylene chloride. On this figure, upstream of pond C-1 in Woman Creek, bis (2-ethylhexyl) phthalate (a common laboratory contaminant) is the only organic with concentrations above the CRQL, except for one sample that had N-Nitrosodiphenylamine. Downstream of pond C-1, in both Woman Creek and the SID, other organics along with the common laboratory contaminants are present. These organic contaminants could be from the 881 Hillside area, which is adjacent to Woman Creek and slightly upstream from Pond C-1.

In addition to the above organics, most sediment locations have reported concentrations of radionuclides and metals (Appendix D). Table 2 in Appendix D lists the radionuclides which have concentrations above the CRQL for each sediment sampling location. The metals concentrations are not summarized in Appendix D (Table 2) because the background metal concentrations for the OU5 sediments have not yet been fully established (see Table 1 in Appendix D). These metal concentrations will be more fully evaluated during the remedial investigation.

Table 2-7 contains a summary of the hits (concentrations above the CRQL) by analyte group for the 18 sediment locations reviewed. There appear to be significant amounts of data from the site wide sediment sampling program (as reviewed above) that can be used to characterize the sediments in OU5. These data will be used in Section 7 to focus the additional data collection effort.

Existing Surface Water Sampling Program

Surface water samples are currently collected monthly to monitor the water quality of the detention ponds and in the Woman Creek drainage. A surface water monitoring program was established several years ago at Rocky Flats facility and is presently being supervised by EG&G personnel. Numerous established surface sampling locations along the drainage area of Woman Creek and within Ponds C-1 and C-2 (Figure 2-1) are sampled on a monthly basis providing there is water present and the water is not frozen. Analytical results from surface water samples along the Woman Creek drainage (Figure 2-1) were reviewed for this Work Plan. A majority of available surface water data is from 1989 and 1990, with a few samples collected prior to 1989. Surface water samples collected as part of the existing program are collected according to Standard Operating Procedure (SOP) SW.3 for surface water.

A compilation of the analytical results (except for radionuclides) for samples from the existing sampling program that have reported concentrations above the CRQL is contained in Appendix E. Radionuclides are not included in this summation because these data could not be properly sorted within the data base. Many of the organic compounds which are listed in Appendix E are common laboratory contaminants (acetone, methylene chloride, toluene, and 2-butanone) (USEPA 1988e). According to the Statement of Work in USEPA Contract Laboratory guidance, these compounds should not be considered significant unless they have concentrations greater than 5 times the CRQL (USEPA 1988e). A review of the organic results from the existing sampling stations (excluding the laboratory contaminants listed above) reveals that most reported concentrations are below the detection limits. Of the organics detected, almost all had concentrations below 40 μg/l, with most concentrations ranging from 5 to 15 μg/l (Appendix E). Many of the surface water sampling locations that have detectible concentrations are predominantly downstream of pond C-1.

A review of the data base indicates that most of the surface water sampling locations (both up- and downstream of the IHSSs in OU5) have detectable concentrations of radionuclides. This suggests that some of the radionuclides detected may represent background concentrations. These upstream concentrations will be further evaluated during the remedial investigation to identify potential sources. Elevated metal concentrations were also reported both up- and downstream of OU5. These variable metal concentrations will be evaluated with respect to background metal concentrations when background values are established for OU5.

In addition to the above surface water data, discharges from Pond C-2 are regularly monitored to comply with an NPDES permit. These discharges are monitored for plutonium, americium, uranium, and tritium (U.S. DOE 1986c). Water quality and flow measurements are also monitored during periods of discharge from Pond C-2. The discharge monitoring reports are sent to EPA and CDH on a regular basis.

2.4.5 Geology and Hydrology

The surficial units near Ponds C-1 and C-2 are primarily valley fill alluvium and colluvium. This is based on the lithology encountered in two alluvial monitoring wells (6486 and 6586) located slightly upstream of these ponds. In both these wells, the valley fill alluvium is approximately 7 to 9 feet thick and is a silty clayey gravel to clayey sand. The gravel is multicolored and is subangular to subrounded. Beneath these surficial deposits is the Arapahoe Formation. This unit is a slightly calcareous yellowish-orange to light olive-gray claystone, with some oxide staining. The shallow nature of the bedrock below ground surface is typical of those areas immediately adjacent to Woman Creek.

The valley fill alluvium may not be present beneath the Detention Ponds since the top 5 to 10 feet of the surficial materials were removed during construction of the ponds (Appendix A). The base of these ponds may be constructed in the Arapahoe Formation. The sediment that has been deposited in the ponds since their construction is unconsolidated and very fine grained.

Groundwater was encountered approximately 5 feet and 7 feet below the ground surface in wells 6586 and 6486, respectively, near Ponds C-1 and C-2 (Figure 2-7). Thus, only several feet of the valley fill alluvium is saturated in this area. It is likely that a thicker section of the alluvium is saturated in the spring, during the high-water stage. Groundwater within the alluvium is thought to flow principally to the east similar to Woman Creek's stream flow. The lithologic characteristics of the bedrock in this area, if similar to the nearby monitoring wells, is primarily a claystone. Little groundwater flow is, therefore, expected to occur through this unit. However, within the uppermost section of the Arapahoe Formation, as observed at various locations beneath the Plant site, subcropping sandstones have been encountered. Thus, further characterization of the Arapahoe Formation beneath these ponds is needed.

2.5 SURFACE DISTURBANCE (IHSS 209), THE SURFACE DISTURBANCE WEST OF IHSS 209 AND THE SURFACE DISTURBANCES SOUTH OF THE ASH PIT AREA

2.5.1 Location and Description

Three separate surface disturbances will be described in this section: IHSS 209, the surface disturbance west of IHSS 209, and the surface disturbances south of the Ash Pits. IHSS 209 is located to the southeast of the Rocky Flats Plant security area, south of Woman Creek and approximately 1,000 feet southeast of Pond C-1 (IHSS 142.10) (Figure 2-7). This area was included as an IHSS because unknown activities took place in this area of shallow excavations and surface disturbances. This IHSS covers approximately 225,000 square feet (5.2 acres) and is located on a long narrow plateau bounded to the north, east and south by a uniform slope leading into the Woman Creek drainage. A dirt road transects this IHSS and loops near the eastern boundary. Three excavations are located within the boundary of this IHSS (Figure 2-7). Two depressions which periodically retain water are present near the northern and southwestern boundary of this unit (Figure 2-7).

A second surface disturbance located approximately 1,500 feet west of IHSS 209 has been added to the OU5 investigation. The area consists of four small disturbed areas symmetrically placed around a fifth disturbed area (Figure 2-7). This disturbance covers are area of approximately 62,500 square feet.

A third surface disturbance area has also been added to the OU5 investigation. This area is located 1,200 feet south of IHSS 133 and south of Woman Creek. This area consists of five former excavation areas (Figure 2-6). These surface disturbances were identified in aerial photographs taken between 1955 and 1988 (U.S. EPA 1988c). There is still surface evidence of some of these disturbances. Two former excavations trend along northeast-southwest axes (Figure 2-6). Each excavation is approximately 30 feet wide by 400 feet long. A horseshoe-shaped area, or the east area, is located northeast of the parallel excavations and a third excavation (3 feet wide by approximately 2 feet deep) is located to the southwest. This excavation trends in a north-south direction across the plateau. A west area is approximately 600 feet by 150 feet and is located upslope (southwest) from the other disturbances.

2.5.2 History

It is not known what activity or activities may have taken place at IHSS 209 or at the surface disturbances south of the Ash Pits. However, the time period in which these areas were disturbed can be estimated from aerial photographs.

IHSS 209 first appears as a disturbed area in a 1955 aerial photograph (U.S. EPA 1988b). The ground was disturbed both west and east of the dirt road; however, no obvious features or equipment can be seen in the photo (Figure 2-7). By 1961, three excavations existed within this IHSS. The depression located near the southwestern boundary of this IHSS appears as a pond in the 1980, 1983, and 1988 aerial photographs. The 1980 aerial photograph also reveals that the western half of the IHSS was beginning to revegetate. By 1988, the only recognizable features on or near this surface disturbance was the presence of the eastern-most excavation and the pond located near the northern boundary of this IHSS (Figure 2-7).

The surface disturbance west of IHSS 209 appears to have been the location of a radio tower installation based on the geometry of the five disturbances at this site. This surface disturbance was observed in a 1955 aerial photograph and was viewed up until about 1971 when the area started revegetating. A radio tower, however, was never viewed in the aerial photographs.

The east excavation area was the first area to be noted as active in the surface disturbances south of the Ash Pits. This was observed in a 1955 aerial photograph. The two parallel excavations became active prior to 1978, as they are visible in the 1978 photo. After 1983, the excavation areas started to revegetate. The west area, located approximately 400 feet southwest of the parallel excavations, became active prior to 1969 (U.S. EPA 1988b). This area is now backfilled with large rocks. The time these rocks were placed is unknown.

2.5.3 Nature of Contamination and Previous Investigations

No previous investigations have been performed near IHSS 209, the surface disturbance west of IHSS 209, or the surface disturbances south of the Ash Pit area. In addition, there are no nearby groundwater monitoring wells that can provide data on these areas.

2.5.4 Surface Drainage

IHSS 209 is located on a plateau. Surface runoff from this unit flows to the northwest, north, and east into Woman Creek drainage and south into Smart Ditch (Figure 2-7). Woman Creek is about 750 feet to the north of IHSS 209 and Smart Ditch about 1400 feet to the south. Both these tributaries are about 140 feet lower in elevation then IHSS 209. Since this IHSS is located atop a plateau, it receives little runoff from any upslope areas.

The surface disturbance west of IHSS 209 is located on a northward facing slope, approximately 1500 feet south of Woman creek (Figure 2-7). This unit receives runoff from a plateau area located a few hundred feet to the southwest with surface drainage flowing northward into Woman Creek.

The surface disturbances south of the Ash Pit area are also located on a narrow plateau (Figure 2-6). Surface runoff flows to the north, northeast, or west, toward Woman Creek. Woman Creek is located approximately 400 feet to the north of these surface disturbances and is between 20 to 80 feet lower in elevation. This area, like IHSS 209, receives little surface runoff from any upslope areas.

2.5.5 Geology and Hydrology

The geology beneath and near IHSS 209 and the surface disturbances south of the Ash Pit area has been characterized based on the geographical location of the units, lithologic information obtained from a monitoring well drilled on a similar plateau area and from the surficial geological map of the OU5 area (Figure 1-5). As was encountered in the monitoring well (P416489), located 2,500 feet to the north-northeast of IHSS 209, the Rocky Flats Alluvium and the Arapahoe Formation are the geologic units that underlie these areas. The Rocky Flats Alluvium in the monitoring well is approximately 20-30 feet thick and consists of poorly sorted, multicolored, sandy gravelly clay to gravelly clayey sand. The Arapahoe Formation is a moderately to well sorted sandy silty claystone to claystone, with some oxide staining. It is likely that these formations underlie the surface disturbances since these plateau areas are characteristic of the deposition of Rocky Flats Alluvium on the surface of the Arapahoe Formation. The geology beneath the surface disturbance west of IHSS 209 has also been characterized based on its geographical location, as no wells or borings have been drilled in this area. Therefore, the surficial geologic unit beneath this unit is likely to be Rocky Flats Alluvium underlain by the Arapahoe Formation. Further characterization of the lithology of these formations is, however, needed.

The characteristics of the hydrologic system(s) are unknown beneath these surface disturbances because of the lack of nearby wells. Groundwater probably occurs at the base of the Rocky Flats Alluvium just above the less-permeable Arapahoe Formation; however, further characterization of the nature of the Rocky Flats Alluvium and Arapahoe Formation is needed.

2.6 CONCEPTUAL MODELS

Conceptual models describe a site and its environs and present hypotheses regarding the contaminants, their routes of migration, and their potential impact on receptors. Since little is known concerning the contaminants and their routes of migration in OU5, the conceptual models must be very general. The hypotheses of the models are tested, refined and modified throughout the RFI/RI process.

A generic Phase I conceptual model has been developed for IHSSs in OU5 and is presented in the following sections. The model will be refined and modified as appropriate to each IHSS in the RFI/RI Report.

2.6.1 IHSS Locations and Sources

The Original Landfill (IHSS 115) is located south of the west access road on a slope leading down to Woman Creek. This unit received approximately two million cubic feet of miscellaneous plant wastes during its operation. Plant wastes included such things as solvents, paints, paint thinners, oil, pesticides, and cleaners. Metals such as beryllium, uranium, lead, and chromium are also suspected to have been buried in the landfill. The potential source of contamination at this IHSS is the material buried in the landfill.

The Incinerator, Ash Pits, and Concrete Wash Pad (IHSS 133) are located south of the west access road on a relatively flat, grassy area. The Incinerator was used to burn general plant wastes. Ashes from the Incinerator were placed in trenches or pits (Ash Pits 1 through 4) or pushed over the side of the hill into Woman Creek drainage and/or onto the Concrete Wash Pad. Along with general plant wastes, it is possible that uranium-238 was also burned and subsequently buried in the Ash Pits. Following shutdown of the Incinerator, the Ash Pits were covered with fill. The Concrete Wash Pad was principally used to dispose of waste concrete from concrete trucks involved in construction at the Rocky Flats Plant facility and as an area to wash concrete trucks. The source of contamination at the Ash Pits, if present, is the materials in the pits.

Detention Ponds C-1 and C-2 (IHSSs 142.10 and 142.11) along the Woman Creek drainage and the SID are used primarily to capture and control surface water runoff. Pond C-1 receives water from Woman Creek, while Pond C-2 receives water from the SID and, consequently, surface water runoff from the southern part of the production facilities. Historically, water and sediment samples from these ponds have occasionally contained low concentrations of radionuclides. These contaminants, however, have primarily been found in the bottom sediments of the ponds. Analytical data from water samples taken from Ponds C-1 and C-2 during several sampling periods in 1989 detected various radionuclides and other compounds (see Subsection 2.4.4). The potential sources of contamination at Ponds C-1 and C-2 are sediments and water in the ponds.

No field sampling investigations have been conducted at the Surface Disturbance (IHSS 209) and no waste disposal activities are known to have taken place. Thus, while exposure pathways exist for this IHSS, the presence of hazardous materials within this IHSS has not been proven.

No previous investigations have been performed at the surface disturbances south of the Ash Pits or at the surface disturbance west of IHSS 209, and there have been no reports of waste disposal activities or spills. The presence or absence of hazardous substances will be investigated during the Phase I Investigation.

2.6.2 Potential Pathways of Exposure

Air Pathway. Sources of contamination exposed at the surface of any IHSS have the potential to become airborne. The air pathway includes both airborne particulates and gaseous emissions.

Surface Water Pathway. Sources of contamination exposed to surface water have the potential to enter the surface water pathway. In addition, surface water in Woman Creek or the C-series Ponds is considered a source for those units. The primary surface water pathway is Woman Creek and it's tributaries and diversions.

Groundwater Pathway. Migration of contaminants by infiltration and percolation of water through a source into groundwater is another potential pathway of exposure. Migration will occur into the underlying groundwater system and then in the direction of movement of the particular aquifer encountered. The primary flow path of the aquifers is expected to be to the east.

Direct Contact. A fourth pathway exists through direct contact with sources, or contaminated soil, sediment or water.

2.6.3 Receptors

Potential receptors of contaminants are humans on-site and off-site, primarily downgradient, and on-site and off-site biota. Biota and on-site humans are more likely to have the potential for direct contact.

3.0
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This section provides a preliminary identification of chemical-specific Applicable or Relevant and Appropriate Requirements (ARARs) for groundwater, surface water, and soils at Operable Unit 5 so that appropriate analytical detection limits are used during the RCRA Facility Investigation/Remedial Investigation. Use of appropriate detection limits is necessary to allow evaluation of compliance with ARARs in the Corrective Measures Study/Feasibility Study (CMS/FS) report. As described in Section 3.2, evaluation and establishment of location-specific ARARs are a part of the RI process and will be addressed in the RFI/RI Report. Chemical-specific ARARs will be established in the RFI/RI Report. Identification of action-specific ARARs and remediation goals is a part of the feasibility study process and will be addressed in the CMS/FS Report.

3.1 THE ARAR BASIS

The basis for ARARs is cited in Section 121(d) of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), which requires that Fund-financed, enforcement, and federal facility remedial actions comply with all applicable or relevant and appropriate promulgated federal and state environmental or facility siting laws. For the purposes of identification and notification of promulgated state standards, the term "promulgated" means that the standards are of general applicability and are legally enforceable. (National Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) 300.400(g)(4).)

Health-based, chemical-specific ARARs pertinent to groundwater, surface water, and soils (environmental media addressed by this work plan) have been identified for the Environmental Protection Agency's (EPA) Contract Laboratory Program (CLP), target compound list (TCL) for organic, and target analyte list (TAL) for inorganic compounds, as well as radionuclides and conventional pollutants. The chemical-specific ARARs are primarily derived from federal and state health and environmental statutes and regulations. As discussed below, in some instances, these standards are classified as terms "to be considered" (TBC). A summary of potential chemical-specific ARARs/TBCs for possible contaminants in Operable Unit (OU) 5 groundwater is presented in Table 3-1. Similarly, potential ARARs/TBCs for OU5 surface water are summarized in Tables 3-2 and 3-3.

One medium for which chemical-specific ARARs do not currently exist is soils. As the remedial investigation proceeds, information will become available from the baseline risk assessment that will allow a determination of acceptable contaminant concentrations in soils to ensure environmental "protectiveness." This is discussed further in Section 3.5.

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991) GROUNDWATER QUALITY STANDARDS (ug/l)

				FEDERAL STANDARDS					STATE STANDARDS (TBCs)							
									CDH WQCC Groundwater Quality Standards (d)							
									Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40CFR264.94) (c)	Tables A & B (d)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
Bicarbonate	A	10	E310.1													
Carbonate	A	10	E310.1													
Chloride	A	5	E325	250,000 *							250,000					
Chlorine	A															
Fluoride	A	5	E340	4,000; 2,000*		4,000				4,000		2,000				
N as Nitrate	A	5	E353.1	10,000			10,000			10,000						
N as Nitrate+Nitrite	A	5	E353.1		10,000		10,000					100,000				
N as Nitrite	A	5	E354.1		1,000		1,000			1,000		10,000				
Sulfate	A	5	E375.4	250,000*							250,000					
Sulfide	A															
Coliform (total)	B	1	SM9221C	1/100 ml						1/100 ml						
Ammonia as N	C	5	E350													
Dioxin	D		d						0.00000022 (7)					0.000000013		
Sulfur	E	100,000	E600													
Dissolved Oxygen	FP	0.5	SM4500													
pH	FP	0.1	E150.1	6.5–8.5 *							6.5–8.5	6.5–8.5				
Specific Conductance	FP	1	E120.1													
Temperature	FP															
Boron	I	5	E6010									750				
Total Dissolved Solids	I	10	E160.1	500,000*									400,000 (1)			
Aluminum	M	200	CT		50 to 200*							5,000				
Antimony	M	60	CT													
Arsenic	M	10	CT	50				50		50		100				
Arsenic III	M															
Arsenic V	M															
Barium	M	200	CT	1,000	2,000 (e)		2,000 (e)	1,000		1,000						

3-1.1

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
GROUNDWATER QUALITY STANDARDS (ug/l)

				FEDERAL STANDARDS					STATE STANDARDS (TBCs)							
									CDH WQCC Groundwater Quality Standards (d)							
									Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40CFR264.94) (c)	Tables A & B (d)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
Beryllium	M	5	CT									100				
Cadmium	M	5	CT	10	5		5	10		10		10				
Calcium	M	5,000	CT													
Cesium	M	1,000	NC													
Chromium	M	10	CT	50	100		100	50		50		100				
Chromium III	M	5	SW8467196													
Chromium VI	M	10	E218.5													
Cobalt	M	50	CT									50				
Copper	M	25	CT	1,000 *			1300 (f)				1,000	200				
Cyanide	M	10	CT							200						
Iron	M	100	CT	300 *							300	5,000				
Lead	M	5	CT	50			0 (f)	50		50		100				
Lithium	M	100	NC									2,500				
Magnesium	M	5000	CT													
Manganese	M	15	CT	50 *							50	200				
Mercury	M	0.2	CT	2	2		2	2		2		10				
Molybdenum	M	200	NC													
Nickel	M	40	CT									200				
Potassium	M	5000	CT													
Selenium	M	5	CT	10	50		50	10		10		20				
Silver	M	10	CT	50	100 *			50		50						
Sodium	M	5000	CT													
Strontium	M	200	NC													
Thallium	M	10	CT													
Tin	M	200	NC													
Titanium	M	10	E6010													
Tungsten	M	10	E6010													
Vanadium	M	50	CT									100				
Zinc	M	20	CT	5,000 *							5,000	2,000				

3-1.2

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991) GROUNDWATER QUALITY STANDARDS (ug/l)

				FEDERAL STANDARDS					STATE STANDARDS (TBCs)							
									CDH WQCC Groundwater Quality Standards (d)							
									Statewide	Site-Specific (g)						
				SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40CFR264.94) (c)	Tables A & B (d)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	PQL MDL	Method (6)												Woman Creek	Walnut Creek
2,4,5-TP Silvex	P		d	10	50		50	10	10							
2,4-Dichlorophenoxyacetic acid (2,4-D)	P		d	100	70		70	100	100							
	P															
Aldicarb	P				3 (e)		1 (e)		10							
Aldrin	P	0.05	CP						0.002 (7)					0.0000784		
Bromacil	P															
Carbofuran	P		d		40		40		36							
Chloranil	P															
Chlordane (alpha)	P	0.5	CP		2		0		0.03 (7)					0.00046		
Chlordane (gamma)	P	0.5	CP		2		0		0.03 (7)					0.00046		
Chlorpyrifos	P															
DDT	P	0.1	CP						0.1 (7)					0.000024		
DDT metabolite (DDD)	P	0.1	CP													
DDT metabolite (DDE)	P	0.1	CP													
Demeton	P															
Diazinon	P															
Dieldrin	P	0.1	CP						0.002 (7)					0.000071		
Endosulfan I	P	0.05	CP													
Endosulfan II	P	0.1	CP													
Endosulfan sulfate	P	0.1	CP													
Endrin	P	0.1	CP	0.2				0.2	0.2							
Endrin Ketone	P	0.1	CP													
Guthion	P															
Heptachlor	P	0.05	CP		0.4		0		0.008 (7)					0.00028		
Heptachlor Epoxide	P	0.05	CP		0.2		0		0.004 (7)							
Hexachlorocyclohexane, Alpha	P	0.05	CP											0.0092		
Hexachlorocyclohexane, Beta	P	0.05	CP											0.0163		
Hexachlorocyclohexane, Delta	P	0.05	CP													

3-1.3

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
GROUNDWATER QUALITY STANDARDS (ug/l)

				FEDERAL STANDARDS					STATE STANDARDS (TBCs)							
									CDH WQCC Groundwater Quality Standards (d)							
									Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40CFR264.94) (c)	Tables A & B (d)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
Hexachlorocyclohexane, Technical	P		f											0.0123		
Hexachlorocyclohexane, Lindane	P	0.05	CP	4	0.2		0.2	4.0	4					0.0186		
Malathion	P															
Methoxychlor	P	0.5	CP	100	40		40	100	100	100						
Mirex	P															
Parathion	P															
PCBs	P	0.5	CP		0.5		0		0.005 (7)					0.000079		
Simazine	P		e											4.0		
Toxaphene	P	1	CP		3		0	5.0	5	5						
Vaponite 2	P															
Aroclor 1016	PP	0.5	CP													
Aroclor 1221	PP	0.5	CP													
Aroclor 1232	PP	0.5	CP													
Aroclor 1242	PP	0.5	CP													
Aroclor 1248	PP	0.5	CP													
Aroclor 1254	PP	1	CP													
Aroclor 1260	PP	1	CP													
Atrazine	PP		e		3		3							3.0		
Americium (pCi/l)	R														0.05	0.05
Americium 241 (pCi/l)	R	0.01														
Cesium 134 (pCi/l)	R	1							80 (2)						80	80
Cesium 137 (pCi/l)	R	1														
Gross Alpha (pCi/l)	R	2		15 (8)						15					7	11
Gross Beta (pCi/l)	R	4		50 (4 mrem/yr)						4 mrem/yr					5	19
Plutonium 238+239+240 (pCi/l)	R	0.01							15 (2)							
Plutonium (pCi/l)	R														0.05	0.05
Radium 226+228 (pCi/l)	R	0.5/1.0 (4)		5					5 (2)							
Strontium 89+90 (pCi/l)	R	1														

3-1.4

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991) GROUNDWATER QUALITY STANDARDS (ug/l)

				FEDERAL STANDARDS					STATE STANDARDS (TBCs)							
									CDH WQCC Groundwater Quality Standards (d)							
				SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40CFR264.94) (c)	Statewide	Site-Specific (g)						
									Tables A & B (d)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides	
Parameter	Type (5)	PQL MDL	Method (6)												Woman Creek	Walnut Creek
Strontium 90 (pCi/l)	R			8 (3)					8 (2)						8	8
Thorium 230+232 (pCi/l)	R								60 (2)							
Tritium (pCi/l)	R			20,000 (3)					20,000 (2)						500	500
Uranium 233+234 (pCi/l)	R															
Uranium 235 (pCi/l)	R	0.6														
Uranium 238 (pCi/l)	R	0.6														
Uranium (total) (pCi/l)	R														5	10
1,2,4,5-Tetrachlorobenzene	SV		b						2 (7)							
1,2,4-Trichlorobenzene	SV	10	CS													
1,2-Dichlorobenzene (ortho)	SV	10	CS		600		600		620							
1,2-Diphenylhydrazine	SV		b						0.05 (7)							
1,3-Dichlorobenzene (meta)	SV	10	CS						620							
1,4-Dichlorobenzene (para)	SV	10	CS	75		75			75							
2,4,5-Trichlorophenol	SV	50	CS						700							
2,4,6-Trichlorophenol	SV	10	CS						2 (7)					1.2		
2,4-Dichlorophenol	SV	10	CS						21							
2,4-Dimethylphenol	SV	10	CS													
2,4-Dinitrophenol	SV	50	CS													
2,4-Dinitrotoluene	SV	10	CS													
2-Chloronaphthalene	SV	10	CS													
2-Chlorophenol	SV	10	CS													
2-Methylnaphthalene	SV	10	CS													
2-Methylphenol	SV	10	CS													
2-Nitroaniline	SV	50	CS													
2-Nitrophenol	SV	10	CS													
3,3-Dichlorobenzidine	SV	20	CS													
3-Nitroaniline	SV	50	CS													
4,6-Dinitro-2-methylphenol	SV	50	CS													

3-1.5

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991) GROUNDWATER QUALITY STANDARDS (ug/l)

				FEDERAL STANDARDS					STATE STANDARDS (TBCs)							
									CDH WQCC Groundwater Quality Standards (d)							
									Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40CFR264.94) (c)	Tables A & B (d)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
4-Bromophenyl Phenylether	SV	10	CS													
4-Chloroaniline	SV	10	CS													
4-Chlorophenyl Phenyl Ether	SV	10	CS													
4-Chloro-3-methylphenol	SV	10	CS													
4-Methylphenol	SV	10	CS													
4-Nitroaniline	SV	50	CS													
4-Nitrophenol	SV	50	CS													
Acenaphthene	SV	10	CS													
Anthracene	SV	10	CS													
Benzidine	SV		d						0.0002 (7)	0.1				0.00012		
Benzoic Acid	SV	50	CS													
Benzo(a)anthracene	SV	10	CS													
Benzo(a)pyrene	SV	10	CS													
Benzo(b)fluoranthene	SV	10	CS													
Benzo(g,h,i)perylene	SV	10	CS													
Benzo(k)fluoranthene	SV	10	CS													
Benzyl Alcohol	SV	10	CS													
bis(2-Chloroethoxy)methane	SV	10	CS													
bis(2-Chloroethyl)ether	SV	10	CS						0.03 (7)					0.0000037		
bis(2-Chloroisopropyl)ether	SV	10	CS													
bis(2-Ethylhexyl)phthalate	SV	10	CS													
Butadiene	SV															
Butylbenzylphthalate	SV	10	CS													
Chlorinated Ethers	SV															
Chlorinated Napthalenes	SV															
Chloroalkylethers	SV	10	CS													
Chlorophenol	SV									1						
Chrysene	SV	10	CS													
Dibenzofuran	SV	10	CS													

3-1.6

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991) GROUNDWATER QUALITY STANDARDS (ug/l)

				FEDERAL STANDARDS					STATE STANDARDS (TBCs)							
									CDH WQCC Groundwater Quality Standards (d)							
									Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40CFR264.94) (c)	Tables A & B (d)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
Dibenz(a,h)anthracene	SV	10	CS													
Dichlorobenzenes	SV															
Dichlorobenzidine	SV	20	CS											0.01		
Diethylphthalate	SV	10	CS													
Dimethylphthalate	SV	10	CS													
Dinitrotoluene	SV	10	CS													
Di-n-butylphthalate	SV	10	CS													
Di-n-octylphthalate	SV	10	CS													
Ethylene glycol	SV		d						7,000							
Fluoranthene	SV	10	CS													
Fluorene	SV	10	CS													
Formaldehyde	SV															
Haloethers	SV															
Hexachlorobenzene	SV	10	CS						0.02 (7)					0.00072		
Hexachlorobutadiene	SV	10	CS						14					0.45		
Hexachlorocyclopentadiene	SV	10	CS						49							
Hexachloroethane	SV	10	CS											1.9		
Hydrazine	SV															
Indeno(1,2,3-cd)pyrene	SV	10	CS													
Isophorone	SV	10	CS						1,050							
Naphthalene	SV	10	CS													
Nitrobenzene	SV	10	CS						3.5 (7)							
Nitrophenols	SV															
Nitrosamines	SV															
Nitrosodibutylamine	SV		b											0.0064		
Nitrosodiethylamine	SV		b											0.0008		
Nitrosodimethylamine	SV		b											0.0014		
Nitrosopyrrolidine	SV		b											0.016		
N-Nitrosodiphenylamine	SV	10	CSb											4.9		

3-1.7

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991) GROUNDWATER QUALITY STANDARDS (ug/l)

				FEDERAL STANDARDS					STATE STANDARDS (TBCs)							
									CDH WQCC Groundwater Quality Standards (d)							
									Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40CFR264.94) (c)	Tables A & B (d)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
N-Nitroso-di-n-dipropylamine	SV	10	CSb													
Pentachlorinated Ethanes	SV		b													
Pentachlorobenzene	SV		b						6 (7)							
Pentachlorophenol	SV	50	CS		1 (e)		0 (e)		200							
Phenanthrene	SV	10	CS													
Phenol	SV	10	CS							1						
Phthalate Esters	SV															
Polynuclear Aromatic Hydrocarbons	SV		b											0.0028		
Vinyl Chloride	SV	10	CV	2		0			2							
1,1,1-Trichloroethane	V	5	CV	200		200			200							
1,1,2,2-Tetrachloroethane	V	5	CV											0.17		
1,1,2-Trichloroethane	V	5	CV						28							
1,1-Dichloroethane	V	5	CV											0.6		
1,1-Dichloroethene	V	5	CV	7		7			7							
1,2-Dichloroethane	V	5	CV	5		0			5							
1,2-Dichloroethene (cis)	V		a		70		70		70							
1,2-Dichloroethene (total)	V	5	CV													
1,2-Dichloroethene (trans)	V		a		100		100		70							
1,2-Dichloropropane	V	5	CV		5		0		0.56 (7)							
1,3-Dichloropropene (cis)	V	5	CV													
1,3-Dichloropropene (trans)	V	5	CV													
2-Butanone	V	10	CV													
2-Hexanone	V	10	CV													
4-Methyl-2-pentanone	V	10	CV													
Acetone	V	10	CV													
Acrylonitrile	V		c											0.058		
Benzene	V	5	CV	5		0			5							
Bromodichloromethane	V	5	CV													

3-1.8

TABLE 3-1 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991) GROUNDWATER QUALITY STANDARDS (ug/l)

				FEDERAL STANDARDS					STATE STANDARDS (TBCs) CDH WQCC Groundwater Quality Standards (d)							
									Statewide	Site-Specific (g)						
Parameter	Type (5)	PQL MDL	Method (6)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	RCRA Subpart F Concentration Limit (40CFR264.94) (c)	Tables A & B (d)	Table 1 Human Health	Table 2 Secondary Drinking	Table 3 Agriculture	Table 4 TDS	Table 5 Chronic	Table 6 Radionuclides Woman Creek	Table 6 Radionuclides Walnut Creek
Bromoform	V	5	CV													
Bromomethane	V	10	CV													
Carbon Disulfide	V	5	CV													
Carbon Tetrachloride	V	5	CV	5		0			5							
Chlorinated Benzenes	V	10	CV/CS													
Chlorobenzene	V	5	CV/CS		100		100		300							
Chloroethane	V	10	CV													
Chloroform	V	5	CV	Tot THM <100**					Tot THM <100**					0.19		
Chloromethane	V	10	CV													
Dibromochloromethane	V	5	CV													
Dichloroethenes	V															
Ethyl Benzene	V	5	CV		700		700		680							
Ethylene dibromide	V		d		0.05		0		0.0004							
Ethylene Oxide	V															
Halomethanes	V			100					100					0.19		
Methylene Chloride	V	5	CV													
Pyrene	V	10	CS													
Styrene	V	5	CV		100		100									
Tetrachloroethanes	V	5	CV													
Tetrachloroethene	V	5	CV		5		0		10					0.8		
Toluene	V	5	CV		1,000		1,000		2,420							
Trichloroethanes	V	5	CV													
Trichloroethene	V	5	CV	5		0			5							
Vinyl Acetate	V	10	CV													
Xylenes (total)	V	5	CV		10,000		10,000									

3-1.9

EXPLANATION OF TABLE

* = *secondary maximum contaminant* level; TBCs

** = total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane

CDH	= Colorado Department of Health
CLP	= Contract Laboratory Program
EPA	= Environmental Protection Agency
pCi/l	= picocuries per liter
PCB	= polychlorinated biphenyl
PQL	= Practical Quantitation Limit
RCRA	= Resource Conservation and Recovery Act
SDWA	= Safe Drinking Water Act
TAL	= Target Analyte List
THM	= Total Trihalomethanes
TIC	= Tentatively Identified Compound
MDL	= Minimum Detection Limit for radionuclides (pCi/l)
ug/l	= micrograms per liter
VOA	= Volatile Organic Analysis
WQCC	= Water Quality Control Commission

(1) TDS standard – see Table 4 in (d); standard is 400 mg/l or 1.25 times the background level, whichever is least restrictive

(2) radionuclide standards – see sec. 3.11.5(c)2 in (d)

(3) If both strontium-90 and tritium are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 *mrem/yr*.

(4) MDL for Radium 226 is 0.5; MDL for radium 228 is 1

(5) type abbreviations are: A=anion; B=bacteria; C=cation; I=indicator; FP=field parameter; M=metal; P=pesticide; PP=pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile

(6) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TICs in CS; c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.

(7) Standard is below (more stringent than) PQL, therefore PQL is standard.

(8) Value for gross alpha excludes uranium.

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of 5/1990)

(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective July 30, 1992 (56 Federal Register 3526; 1/30/1991)

(c) NCP, 40 CFR 300; NCP Preamble 55 FR 8764; CERCLA Compliance with Other Laws Manual, EPA/540/G-89/006, August 1988

(d) CDH/Water Quality Control Commission, The Basic Standards for Ground Water, 3.11.0 (5 CCR 1002-8) 1/5/1987 amended 9/11/1990

(e) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective January 1, 1993 (56 FR 30266; 7/1/1991)

(f) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142 (56 FR 26460; 6/7/91) effective 11/6/91.

(g) CDH/Water Quality Control Commission, Classifications and Water Quality Standards for Ground Water, 3.12.0 (3/5/1991).

3-1.10

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL	Method (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c)		CWA AWQC for Protection of Human Health/TBCs (c)	
								Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Bicarbonate	A	10	E310.1								
Carbonate	A	10	E310.1								
Chloride	A	5	E325	250,000*				860,000(c)	230,000(c)		
Chlorine	A	1000	E4500					19	11		
Flouride	A	5	E340	4,000; 2,000*		4,000					4,000
N as Nitrate	A	5	E353.1	10,000			10,000			10,000	
N as Nitrate+Nitrite	A	5	E353.1		10,000		10,000				
N as Nitrite	A	5	E354.1		1,000		1,000				
Sulfate	A	5	E375.4	250,000*							
Sulfide	A										
Coliform (Fecal)	B	1	SM9221C	1/100 ml							
Ammonia as N	C	5	E350					Criteria are pH	and temperature	dependent - see	criteria document
Dioxin	D		d					0.01	0.00001	0.000000013	0.000000014
Sulfur	E	100,000	E600								
Dissolved Oxygen	FP	0.5	SM4500					5,000			
pH	FP	0.1	E150.1	6.5-8.5 *					6.5-9		
Specific Conductance	FP	1	E120.1								
Temperature	FP							SS	SS		
Boron	I	5	E6010								
Total Dissolved Solids	I	10	E160.1	500,000*				SS	SS	250,000	
Aluminum	M	200	CT		50 to 200*			750	87		
Antimony	M	60	CT					9,000	1,600	146	45,000
Arsenic	M	10	CT	50						.0022	.0175
Arsenic III	M							360	190		
Arsenic V	M							850	48		
Barium	M	200	CT	1,000	2,000 (f)		2,000 (f)			1,000	
Beryllium	M	5	CT					130	5.3	.0068**	.117**
Cadmium	M	5	CT	10	5		5	3.9 (3)	1.1 (3)	10	

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL	Method (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only
Calcium	M	5,000	CT								
Cesium	M	1,000	NC								
Chromium	M	10	CT	50	100		100				
Chromium III	M	5	SW8467196					1,700	210	170,000	3,433,000
Chromium VI	M	10	E218.5					16	11	50	
Cobalt	M	50	CT								
Copper	M	25	CT	1,000*			1,3000 (f)	18 (3)	12 (3)		
Cyanide	M	10	CT					22	5.2	200	
Iron	M	100	CT	300 *					1,000	300	
Lead	M	5	CT	50			0 (g)	82 (3)	3.2 (3)	50	
Lithium	M	100	NC								
Magnesium	M	5000	CT								
Manganese	M	15	CT	50 *						50	100
Mercury	M	0.2	CT	2	2		2	2.4	0.012	0.144	0.146
Molybdenum	M	200	NC								
Nickel	M	40	CT					1,400 (3)	160 (3)	13.4	100
Potassium	M	5000	CT								
Selenium	M	5	CT	10	50		50	20 (d)	5 (d)	10	
Silver	M	10	CT	50	100 *			4.1 (3)	0.12	50	
Sodium	M	5000	CT								
Strontium	M	200	NC								
Thallium	M	10	CT					1,400 (1)	40 (1)	13	48
Tin	M	200	NC								
Titanium	M	10	E6010								
Tungsten	M	10	E6010								
Vanadium	M	50	CT								
Zinc	M	20	CT	5,000 *				120 (3)	110 (3)		
2,4,5-TP Silvex	P		d	10	50		50				
2,4-Dichlorophenoxyacetic Acid (2,4-D)	P		d	100	70		70				

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL	Method (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c)		CWA AWQC for Protection of Human Health/TBCs (c)	
								Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Aldicarb	P				3 (f)		1 (f)				
Aldrin	P	0.05	CP					3.0		0.000074	0.000079
Bromacil	P										
Carbofuran	P		d		40		40				
Chloranil											
Chlordane (Alpha)	P	0.5	CP		2		0	2.4	0.0043	0.00046	0.00048
Chlordane (Gamma)	P	0.5	CP		2		0	2.4	0.0043	0.00046	0.00048
Chlorpyrifos	P		E619					0.063	0.041		
DDT	P	0.1	CP					1.1	0.0011	0.000024	0.000024
DDT metabolite (DDD)	P	0.1	CP					0.06			
DDT metabolite (DDE)	P	0.1	CP					1,050			
Demeton	P								0.1		
Diazinon	P										
Dieldrin	P	0.1	CP					2.5	0.0019	0.00007	0.000076
Endosulfan I	P	0.05	CP					0.22	0.056	74	159
Endosulfan II	P	0.1	CP								
Endosulfan Sulfate	P	0.1	CP								
Endrin	P	0.1	CP	0.2				0.18	0.0023	1	
Endrin Ketone	P	0.1	CP								
Guthion	P								0.01		
Heptachlor	P	0.05	CP		0.4		0	0.52	0.0038	0.00028	0.00029
Heptachlor Epoxide	P	0.05	CP		0.2		0				
Hexachlorocyclohexane, Alpha	P	0.05	CP							0.0092	0.031
Hexachlorocyclohexane, Beta	P	0.05	CP							0.0163	0.0547
Hexachlorocyclohexane, Delta	P	0.05	CP								
Hexachlorocyclohexane, Technical	P		f							0.0123	0.0414
Hexachlorocyclohexane, (Lindane) Gama	P	0.05	CP	4	0.2		0.2	2.0	0.08		
Malathion	P								0.01		
Methoxychlor	P	0.5	CP	100	40		40		0.03	100	
Mirex	P								0.001		

TABLE 3–2 POTENTIAL CHEMICAL–SPECIFIC ARARs/TBCs (August 1, 1991) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL	Method (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only
Parathion	P							0.065	0.013		
PCBs	P	0.5	CP		0.5		0	2.0	0.014	0.000079	0.000079
Simazine	P		e								
Toxaphene	P	1	CP		3		0	0.73	0.0002	0.0071	0.00073
Vaponite 2	P										
Aroclor 1016	PP	0.5	CP								
Aroclor 1221	PP	0.5	CP								
Aroclor 1232	PP	0.5	CP								
Aroclor 1242	PP	0.5	CP								
Aroclor 1248	PP	0.5	CP								
Aroclor 1254	PP	1	CP								
Aroclor 1260	PP	1	CP								
Atrazine	PP		e		3		3				
Americium (pCi/l)	R										
Americium 241 (pCi/l)	R	0.01									
Cesium 134 (pCi/l)	R	1									
Cesium 137 (pCi/l)	R	1									
Gross Alpha (pCI/l)	R	2		15 (10)							15
Gross Beta (pCi/l)	R	4		50 (4 mrem/yr)							
Plutonium (pCi/l)	R										
Plutonium 238+239+240 (pCi/l)	R	0.01									
Radium 226+228 (pCi/l)	R	0.5/0.1 (9)		5							5
Strontium 89+90 (pCi/l)	R	1									
Strontium 90 (pCi/l)	R			8 (6)							8
Thorium 230+232 (pCi/l)	R										
Tritium (pCi/l)	R			20,000 (6)							
Uranium 233+234 (pCi/l)	R										
Uranium 235 (pCi/l)	R	0.6									
Uranium 238 (pCi/l)	R	0.6									

3-2.4

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL	Method (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only
Uranium (total) (pCi/l)	R										
1,2,4,5-Tetrachlorobenzene	SV		b							38	48
1,2,4-Trichlorobenzene	SV	10	CS								
1,2-Dichlorobenzene (ortho)	SV	10	CS		600		600				
1,2-Diphenylhydrazine	SV		b					270 (1)			
1,3-Dichlorobenzene (meta)	SV	10	CS								
1,4-Dichlorobenzene (para)	SV	10	CS	75		75					
2,4,5-Trichlorophenol	SV	50	CS							2,800	
2,4,6-Trichlorophenol	SV	10	CS						970 (1)	1.2 **	3.6 **
2,4-Dichlorophenol	SV	10	CS					2,020 (1)	365 (1)	3,090	
2,4-Dimethylphenol	SV	10	CS					2,120 (1)			
2,4-Dinitrophenol	SV	50	CS								
2,4-Dinitrotoluene	SV	10	CS							0.11 **	9.1 **
2-Chloronaphthalene	SV	10	CS								
2-Chlorophenol	SV	10	CS					4,360 (1)	2,000 (1)		
2-Methylnaphthalene	SV	10	CS								
2-Methylphenol	SV	10	CS								
2-Nitroaniline	SV	50	CS								
2-Nitrophenol	SV	10	CS								
3,3-Dichlorobenzidine	SV	20	CS							0.01	0.02
3-Nitroaniline	SV	50	CS								
4,6-Dinitro-2-methylphenol	SV	50	CS								
4-Bromophenyl Phenylether	SV	10	CS								
4-Chloroaniline	SV	10	CS								
4-Chlorophenyl Phenyl Ether	SV	10	CS								
4-Chloro-3-methylphenol	SV	10	CS					30 (1)			
4-Methylphenol	SV	10	CS								
4-Nitroaniline	SV	50	CS								
4-Nitrophenol	SV	50	CS					230 (1)	150 (1)		

3-2.5

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL	Method (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only
Acenaphthene	SV	10	CS					1,700 (1)	520 (1)		
Anthracene	SV	10	CS								
Benzidine	SV		d					2,500		0.00012	0.00053
Benzoic Acid	SV	50	CS								
Benzo(a)anthracene	SV	10	CS								
Benzo(a)pyrene	SV	10	CS								
Benzo(b)fluoranthene	SV	10	CS								
Benzo(g,h,i)perylene	SV	10	CS								
Benzo(k)fluoranthene	SV	10	CS								
Benzyl Alcohol	SV	10	CS								
bis(2-Chloroethoxy)methane	SV	10	CS								
bis(2-Chloroethyl)ether	SV	10	CS							0.03**	1.36 **
bis(2-Chloroisopropyl)ether	SV	10	CS							34.7	4,360
bis(2-Ethylhexyl)phthalate	SV	10	CS							15,000	50,000
Butadiene	SV										
Butylbenzylphthalate	SV	10	CS								
Chlorinated Ethers	SV										
Chlorinated Napthalenes	SV							1,600 (1)			
Chloroalkylethers	SV	10	CS					238,000 (1)			
Chlorophenol	SV										
Chrysene	SV	10	CS								
Dibenzofuran	SV	10	CS								
Dibenz(a,h)anthracene	SV	10	CS								
Dichlorobenzenes	SV							1,120 (1)	763 (1)	400	2,600
Dichlorobenzidine	SV	20	CS							0.01	0.02
Diethylphthalate	SV	10	CS							350,000	1,800,000
Dimethylphthalate	SV	10	CS							313,000	2,900,000
Dinitrotoluene	SV	10	CS					330 (1)	230 (1)	70	14,300
Di-n-butylphthalate	SV	10	CS								
Di-n-octylphthalate	SV	10	CS								

3-2.6

TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL	Method (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only
Ethylene glycol	SV		d								
Fluoranthene	SV	10	CS					3,980 (1)		42	54
Fluorene	SV	10	CS								
Formaldehyde	SV										
Haloethers	SV							380 (1)	122 (1)		
Hexachlorobenzene	SV	10	CS							0.00072**	0.00074**
Hexachlorobutadiene	SV	10	CS					90 (1)	9.3 (1)	0.45**	50 **
Hexachlorocyclopentadiene	SV	10	CS					7 (1)	5.2 (1)	206	
Hexachloroethane	SV	10	CS					980 (1)	540 (1)	1.9	8.74
Hydrazine	SV										
Indeno(1,2,3-cd)pyrene	SV	10	CS								
Isophorone	SV	10	CS					117,000 (1)		5,200	520,000
Naphthalene	SV	10	CS					2,300 (1)	620 (1)		
Nitrobenzene	SV	10	CS					27,000 (1)		19,800	
Nitrophenols	SV							230 (1)	150 (1)		
Nitrosamines	SV							5,850 (1)			
Nitrosodibutylamine	SV		b							0.0064	0.587
Nitrosodiethylamine	SV		b							0.0008	1.24
Nitrosodimethylamine	SV		b							0.0014	16
Nitrosopyrrolidine	SV		b							0.016	91.9
N-Nitrosodiphenylamine	SV	10	b							4.9 **	16.1 **
N-Nitroso-di-n-dipropylamine	SV	10	b								
Pentachlorinated Ethanes	SV		b					7,240 (1)	1,100 (1)		
Pentachlorobenzene	SV		b							74	85
Pentachlorophenol	SV	50	CS		1 (f)		0 (f)	20 (4)	13 (4)	1,010	
Phenanthrene	SV	10	CS								
Phenol	SV	10	CS					10,200 (1)	2,560 (1)	3,500	
Phthalate Esters	SV		e					940 (1)	3 (1)		
Polynuclear Aromatic Hydrocarbons	SV		b							0.0028**	0.0311**
Vinyl Chloride	SV	10	CV	2		0				2 **	525 **

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TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991) FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL	Method (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only
1,1,1-Trichloroethane	V	5	CV	200		200				18,400	1,030,000
1,1,2,2-Tetrachloroethane	V	5	CV						2,400	0.17**	10.7 **
1,1,2-Trichloroethane	V	5	CV						9,400	0.6**	41.8 **
1,1-Dichloroethane	V	5	CV								
1,1-Dichloroethene	V	5	CV	7		7					
1,2-Dichloroethane	V	5	CV	5		0		118,000	20,000	0.94**	243 **
1,2-Dichloroethene (cis)	V		a		70		70				
1,2-Dichloroethene (total)	V	5	CV								
1,2-Dichloroethene (trans)	V		a		100		100				
1,2-Dichloropropane	V	5	CV		5		0	23,000	5,700		
1,3-Dichloropropene (cis)	V	5	CV					6,060	244 (1)	87	14,100
1,3-Dichloropropene (trans)	V	5	CV					6,060	244 (1)	87	14,100
2-Butanone	V	10	CV								
2-Hexanone	V	10	CV								
4-Methyl-2-pentanone	V	10	CV								
Acetone	V	10	CV								
Acrylonitrile	V		c					7,500	6,000	0.058	0.65
Benzene	V	5	CV	5		0		5,300		0.66**	40 **
Bromodichloromethane	V	5	CV								
Bromoform	V	5	CV								
Bromomethane	V	10	CV								
Carbon Disulfide	V	5	CV								
Carbon Tetrachloride	V	5	CV	5		0		35,200 (1)		0.4**	6.94 **
Chlorinated Benzenes	V	10	CV/CS					250 (1)	50 (1)		
Chlorobenzene	V	5	CV/CS		100		100				
Chloroethane	V	10	CV								
Chloroform	V	5	CV	Tot THM<100 (2				28,900 (1)	1,240 (4)	0.19 **	15.7 **
Chloromethane	V	10	CV								
Dibromochloromethane	V	5	CV								

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TABLE 3-2 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	PQL MDL	Method (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c): Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c): Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c): Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c): Fish Consumption Only
Dichloroethenes	V							11,600 (1)		0.033**	1.85 **
Ethyl benzene	V	5	CV		700		700	32,000 (1)		1,400	3,280
Ethylene dibromide	V		d		0.05		0				
Ethylene oxide	V										
Halomethanes	V			100				11,000 (1)		0.19**	15.7 **
Methylene Chloride	V	5	CV								
Pyrene	V	10	CS								
Styrene	V	5	CV		100		100				
Tetrachloroethanes	V	5	CV					9,320 (1)			
Tetrachloroethene	V	5	CV		5		0	5,280 (1)	840 (1)	0.80**	8.85 **
Toluene	V	5	CV		1,000		1,000	17,500 (1)		14,300	424,000
Trichloroethanes	V	5	CV					18,000 (1)			
Trichloroethene	V	5	CV	5		0		45,000 (1)	21,900 (1)	2.7 **	80.7 **
Vinyl Acetate	V	10	CV								
Xylenes (total)	V	5	CV		10,000		10,000				

EXPLANATION OF TABLE

* = secondary maximum contaminant level, TBCs

** = Human health criteria for carcinogens reported for three risk levels. Value presented is the 10-5 risk level.

AWQC = Ambient Water Quality Criteria
CLP = Contract Laboratory Program
CWA = Clean Water Act
EPA = Environmental Protection Agency
pCi/l = picocuries per liter
PCB = polychlorinated biphenyl
PQL = Practical Quantitation Level
SDWA = Safe Drinking Water Act
SS = Species Specific

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TAL = Target Analyte List
THM = Total Trihalomethanes
TIC = Tentatively Identified Compound
MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis

(1) criteria not developed; value presented is lowest observed effects level (LOEL)
(2) total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(3) hardness dependent criteria
(4) pH dependent criteria (7.8 pH used)
(5) standard is not adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium.
(6) if both strontium-90 and tritium are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 mrem/yr.
(7) type abbreviations are: A=anion; B=bacteria; C=cation; I=indicator; FP=field parameter; M=metal; P=Pesticide; PP=Pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile
(8) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TIC in CS; c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.
(9) MDL for radium 226 is 0.5; MDL for radium 228 is 1.0
(10) Value for gross alpha excludes uranium

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of May 1990)
(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142 and 143, Final Rule, effective July 30, 1992
(c) EPA, Quality Criteria for Protection of Aquatic Life, 1986
(d) EPA, National Ambient Water Quality Criteria for Selenium - 1987
(e) EPA, National Ambient Water Quality Criteria for Chloride - 1988
(f) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, and 143, Final Rule (56 FR 30266; 7/1/1991) effective 1/1/1993.
(g) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142 (56 FR 26460; 6/7/1991) effective 11/6/1991.

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TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

				Statewide Standards (a)							Basin Standards (b)		Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7)						
				Tables A,B Carcinogens/ Noncarcinogens (2)	Table C Aquatic Life		Tables I,II,III (1) Aquatic Life				Organics (12)		Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radionuclide	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type (10)	PQL MDL	Method (11)		Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (6)	Aquatic Life	Water Supply				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Bicarbonate	A	10	E310.1																
Carbonate	A	10	E310.1																
Chloride	A	5	E325							250,000						3	3		
Chlorine	A				3	3										3	3		
Fluoride	A	5	E340							2,000									
N as Nitrate	A	5	E353.1						100,000	10,000						10,000	10,000		
N as Nitrate+Nitrite	A	5	E353.1						100,000	10,000									
N as Nitrite	A	5	E354.1				SS	SS	10,000	1,000						1,000	1,000		
Sulfate	A	5	E375.4							250,000						250,000	250,000		
Sulfide	A							2		50									
Coliform (Fecal)	B	1	SM9221C							2000/100 ml									
Ammonia as N	C	5	E350				620	60		5,000						620	60		
Dioxin	D		d	0.00000022 (13)	0.01	0.00001							0.00000022 (13)	0.000000013			0.000000013		
Sulfur	E	100,000	E600													2.0	2.0		
Dissolved Oxygen	FP	0.5	SM4500				5,000	5,000	3,000	3,000						5,000	5,000		
pH	FP	0.1	E150.1				6.5-9.0	6.5-9.0		5.0-9.0						6.5-9	6.5-9		
Specific Conductance	FP	1	E120.1																
Temperature	FP						30 degrees	30 degrees											
Boron	I	5	E6010						750							750	750		
Total Dissolved Solids	I	10	E160.1																
Aluminum	M	200	CT				950	150											
Antimony	M	60	CT																
Arsenic	M	10	CT				360	150	100	50						50			
Arsenic III	M																		
Arsenic V	M																		
Barium	M	200	CT							1,000									
Beryllium	M	5	CT						100										

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TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (10)	PQL MDL	Method (11)	Statewide Standards (a): Tables A,B Carcinogens/ Noncarcinogens (2)	Statewide Standards (a): Table C Aquatic Life Acute Value	Statewide Standards (a): Table C Aquatic Life Chronic Value
Cadmium	M	5	CT			
Calcium	M	5,000	CT			
Cesium	M	1,000	NC			
Chromium	M	10	CT			
Chromium III	M	5	SW8467196			
Chromium VI	M	10	E218.5			
Cobalt	M	50	CT			
Copper	M	25	CT			
Cyanide	M	10	CT			
Iron	M	100	CT			
Lead	M	5	CT			
Lithium	M	100	NC			
Magnesium	M	5000	CT			
Manganese	M	15	CT			
Mercury	M	0.2	CT			
Molybdenum	M	200	NC			
Nickel	M	40	CT			
Potassium	M	5000	CT			
Selenium	M	5	CT			
Silver	M	10	CT			
Sodium	M	5000	CT			
Strontium	M	200	NC			
Thallium	M	10	CT			
Tin	M	200	NC			
Titanium	M	10	E6010			
Tungsten	M	10	E6010			
Vanadium	M	50	CT			
Zinc	M	20	CT			
2,4,5-TP Silvex	P		d	10		

Parameter	Statewide Standards (a): Tables I,II,III (1) Aquatic Life Acute Value (2)	Tables I,II,III (1) Aquatic Life Chronic Value (2)	Tables I,II,III (1) Agricultural Standard (3)	Tables I,II,III (1) Domestic Water Supply (6)	Basin Standards (b): Organics (12) Aquatic Life	Basin Standards (b): Organics (12) Water Supply
Cadmium	TVS	TVS	10	10		
Calcium						
Cesium						
Chromium						
Chromium III	TVS	TVS	100	50		
Chromium VI	16	11	100	50		
Cobalt						
Copper	TVS	TVS	200			
Cyanide	5	5	200	1,000		
Iron		1,000		300 (dis)		
Lead	TVS	TVS	100	50		
Lithium						
Magnesium						
Manganese		1,000	200	50 (dis)		
Mercury	2.4	0.1		2.0		
Molybdenum						
Nickel	TVS	TVS	200			
Potassium						
Selenium	135	17	20	10		
Silver	TVS	TVS		50		
Sodium						
Strontium						
Thallium		15				
Tin						
Titanium						
Tungsten						
Vanadium						
Zinc	TVS	TVS	2,000	5,000		
2,4,5-TP Silvex						

Parameter	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7): Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radionuclide	Stream Segment Table (8) Acute Value	Stream Segment Table (8) Chronic Value	Table 2 Radionuclides Woman Creek	Table 2 Radionuclides Walnut Creek
Cadmium				TVS	TVS		
Calcium							
Cesium							
Chromium							
Chromium III				50			
Chromium VI				TVS	TVS		
Cobalt							
Copper				TVS	TVS		
Cyanide				5	5		
Iron					300 (5)		
Lead				TVS	TVS		
Lithium							
Magnesium							
Manganese					50 (5)		
Mercury					0.01		
Molybdenum							
Nickel				TVS	TVS		
Potassium							
Selenium				10			
Silver				TVS	TVS		
Sodium							
Strontium							
Thallium							
Tin							
Titanium							
Tungsten							
Vanadium							
Zinc				TVS	TVS		
2,4,5-TP Silvex	10						

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TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (10)	PQL MDL	Method (11)	Statewide Standards (a): Tables A,B Carcinogens/ Noncarcinogens (2)	Statewide Standards (a): Table C Aquatic Life Acute Value	Statewide Standards (a): Table C Aquatic Life Chronic Value	Statewide Standards (a): Tables I,II,III (1) Aquatic Life Acute Value (2)	Statewide Standards (a): Tables I,II,III (1) Aquatic Life Chronic Value (2)	Statewide Standards (a): Tables I,II,III (1) Agricultural Standard (3)	Statewide Standards (a): Tables I,II,III (1) Domestic Water Supply (6)	Basin Standards (b): Organics (12) Aquatic Life	Basin Standards (b): Organics (12) Water Supply	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7): Tables A,B (2)	Segment 4 & 5: Table C Fish & Water Ingestion	Segment 4 & 5: Table D Radionuclide	Segment 4 & 5: Stream Segment Table (8) Acute Value	Segment 4 & 5: Stream Segment Table (8) Chronic Value	Segment 4 & 5: Table 2 Radionuclides Woman Creek	Segment 4 & 5: Table 2 Radionuclides Walnut Creek
2,4-D	P		d	100								100	100						
Aldicarb	P			10									10						
Aldrin	P	0.05	CP	0.002 (13)	3						0.003		0.002 (13)	0.000074			0.000074		
Bromacil	P																		
Carbofuran	P		d	36									36						
Chloranil	P																		
Chlordane (alpha)	P	0.5	CP	0.03 (13)	2.4	0.0043							0.03 (13)	0.00046			0.00046		
Chlordane (gamma)	P	0.5	CP	0.03 (13)	2.4	0.0043							0.03 (13)	0.00046			0.00046		
Chlorpyrifos	P				0.083	0.041													
DDT	P	0.1	CP	0.1 (13)	1.1	0.001					0.001		0.1 (13)	0.000024			0.000024		
DDT metabolite (DDD)	P	0.1	CP		0.6						0.001								
DDT metabolite (DDE)	P	0.1	CP		1,050						0.001								
Demeton	P					0.1					0.1								
Diazinon	P																		
Dieldrin	P	0.1	CP	0.002 (13)	2.5	0.0019					0.003		0.002 (13)	0.000071			0.000071		
Endosulfan I	P	0.05	CP		0.22	0.056					0.003								
Endosulfan II	P	0.1	CP																
Endosulfan Sulfate	P	0.1	CP																
Endrin	P	0.1	CP	0.2	0.18	0.0023					0.004		0.2						
Endrin Ketone	P	0.1	CP																
Guthion	P					0.01					0.01								
Heptachlor	P	0.05	CP	0.008 (13)	0.52	0.0038					0.001	0.2	0.008 (13)	0.00028			0.00028		
Heptachlor epoxide	P	0.05	CP	0.004 (13)									0.004 (13)						
Hexachlorocyclohexane, Alpha	P	0.05	CP											0.0092			0.0092		
Hexachlorocyclohexane, Beta	P	0.05	CP											0.0163			0.0163		
Hexachlorocyclohexane, Delta	P	0.05	CP																
Hexachlorocyclohexane, Tech.	P		f											0.0123			0.0123		
Hexachlorocyclohexane, Lindane	P	0.05	CP	4	2.0	0.08					0.01	4.0	4	0.0186			0.0186		
Malathion	P					0.1					0.1								
Methoxychlor	P	0.5	CP	100		0.03					0.03	100	100						

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TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (10)	PQL MDL	Method (11)	Statewide Standards (a): Tables A,B Carcinogens/ Noncarcin-ogens (2)	Statewide Standards (a): Table C Aquatic Life Acute Value	Statewide Standards (a): Table C Aquatic Life Chronic Value	Statewide Standards (a): Tables I,II,III (1) Aquatic Life Acute Value (2)	Statewide Standards (a): Tables I,II,III (1) Aquatic Life Chronic Value (2)	Statewide Standards (a): Tables I,II,III (1) Agricultural Standard (3)	Statewide Standards (a): Tables I,II,III (1) Domestic Water Supply (6)	Basin Standards (b): Organics (12) Aquatic Life	Basin Standards (b): Organics (12) Water Supply	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7): Tables A,B (2)	Segment 4 & 5: Table C Fish & Water Ingestion	Segment 4 & 5: Table D Radio-nuclide	Segment 4 & 5: Stream Segment Table (8) Acute Value	Segment 4 & 5: Stream Segment Table (8) Chronic Value	Segment 4 & 5: Table 2 Radionuclides Woman Creek	Segment 4 & 5: Table 2 Radionuclides Walnut Creek
Mirex	P					620					0.001								
Parathion	P					0.013					0.04								
PCBs	P	0.5	CP	0.005 (13)	2.0	0.014					0.001		0.005 (13)	0.000079			0.000079		
Simazine	P		e											4			4		
Toxaphene	P	1	CP	5	0.73	0.0002					0.005	5.0	5						
Vaponite 2	P																		
Aroclor 1016	PP	0.5	CP																
Aroclor 1221	PP	0.5	CP																
Aroclor 1232	PP	0.5	CP																
Aroclor 1242	PP	0.5	CP																
Aroclor 1248	PP	0.5	CP																
Aroclor 1254	PP	1	CP																
Aroclor 1260	PP	1	CP																
Atrazine	PP		e											3			3		
Americium (pCi/l)	R																	0.05	0.05
Americium 241 (pCi/l)	R	0.01													30				
Cesium 134 (pCi/l)	R	1		80 (6)									80		80			80	80
Cesium 137 (pCi/l)	R	1																	
Gross Alpha (pCi/l)	R	2																7	11
Gross Beta (pCi/l)	R	4																5	19
Plutonium (pCi/l)	R																	0.05	0.05
Plutonium 238+239+240 (pCi/l)	R	0.01		15 (6)											15				
Radium 226+228 (pCi/l)	R	0.5/1.0 (14)		5 (6)											5				
Strontium 89+90 (pCi/l)	R	1																	
Strontium 90 (pCi/l)	R			8 (6)											8			8	8
Thorium 230+232 (pCi/l)	R			60 (6)											60				
Tritium (pCi/l)	R			20,000 (6)											20,000			500	500
Uranium 233+234 (pCi/l)	R																		
Uranium 235 (pCi/l)	R	0.6																	

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TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

				Statewide Standards (a)							Basin Standards (b)		Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7)						
				Tables A,B	Table C Aquatic Life		Tables I,II,III (1) Aquatic Life				Organics (12)		Tables A,B	Table C	Table D	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type (10)	PQL MDL	Method (11)	Carcinogens/ Noncarcinogens (2)	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (6)	Aquatic Life	Water Supply	(2)	Fish & Water Ingestion	Radio-nuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek
Uranium 238 (pCi/l)	R	0.6																	
Uranium (total) (pCi/l)	R						TVS	TVS							40			5	10
1,2,4,5-Tetrachlorobenzene	SV		b	2 (13)									2						
1,2,4-Trichlorobenzene	SV	10	CS																
1,2-Dichlorobenzene (ortho)	SV	10	CS	620									620						
1,2-Diphenylhydrazine	SV		b	0.05 (13)									0.05 (13)						
1,3-Dichlorobenzene (meta)	SV	10	CS	620									620						
1,4-Dichlorobenzene (para)	SV	10	CS	75									75						
2,4,5-Trichlorophenol	SV	50	CS	700									700						
2,4,6-Trichlorophenol	SV	10	CS	2.0 (13)		970							2.0 (13)	1.2			1.2		
2,4-Dichlorophenol	SV	10	CS	21	2,020	365							21						
2,4-Dimethylphenol	SV	10	CS		2,120														
2,4-Dinitrophenol	SV	50	CS																
2,4-Dinitrotoluene	SV	10	CS																
2-Chloronaphthalene	SV	10	CS																
2-Chlorophenol	SV	10	CS		4,380	2,000													
2-Methylnaphthalene	SV	10	CS																
2-Methylphenol	SV	10	CS																
2-Nitroaniline	SV	50	CS																
2-Nitrophenol	SV	10	CS																
3,3-Dichlorobenzidine	SV	20	CS											0.01			0.01		
3-Nitroaniline	SV	50	CS																
4,6-Dinitro-2-methylphenol	SV	50	CS																
4-Bromophenyl Phenylether	SV	10	CS																
4-Chloroaniline	SV	10	CS																
4-Chlorophenyl Phenyl Ether	SV	10	CS																
4-Chloro-3-methylphenol	SV	10	CS		30														
4-Methylphenol	SV	10	CS																
4-Nitroaniline	SV	50	CS																

3-3.5

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

				Statewide Standards (a)							Basin Standards (b)		Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7)						
				Tables A,B Carcinogens/ Noncarcin-ogens (2)	Table C Aquatic Life		Tables I,II,III (1) Aquatic Life				Organics (12)		Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type (10)	PQL MDL	Method (11)		Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	Domestic Water Supply (6)	Aquatic Life	Water Supply				Acute Value	Chronic Value	Woman Creek	Walnut Creek
4-Nitrophenol	SV	50	CS																
Acenaphthene	SV	10	CS		1,700	520													
Anthracene	SV	10	CS																
Benzidine	SV		d	0.0002 (13)	2,500						0.1	0.01	0.0002 (13)	0.00012			0.00012		
Benzoic Acid	SV	50	CS																
Benzo(a)anthracene	SV	10	CS																
Benzo(a)pyrene	SV	10	CS																
Benzo(b)fluoranthene	SV	10	CS																
Benzo(g,h,i)perylene	SV	10	CS																
Benzo(k)fluoranthene	SV	10	CS																
Benzyl Alcohol	SV	10	CS																
bis(2-Chloroethoxy)methane	SV	10	CS																
bis(2-Chloroethyl)ether	SV	10	CS	0.03 (13)									0.03 (13)	0.0000037			0.0000037		
bis(2-Chloroisopropyl)ether	SV	10	CS																
bis(2-Ethylhexyl)phthalate	SV	10	CS																
Butadiene	SV																		
Butyl Benzylphthalate	SV	10	CS																
Chlorinated Ethers	SV																		
Chlorinated Napthalenes	SV																		
Chloroalkylethers	SV	10	CS																
Chlorophenol	SV										1.0	1.0							
Chrysene	SV	10	CS																
Dibenzofuran	SV	10	CS																
Dibenz(a,h)anthracene	SV	10	CS																
Dichlorobenzenes	SV																		
Dichlorobenzidine	SV	20	CS											0.01			0.01		
Diethylphthalate	SV	10	CS																
Dimethylphthalate	SV	10	CS																
Dinitrotoluene	SV	10	CS		330	230													
Di-n-butylphthalate	SV	10	CS																

3-3.6

TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991) STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

				Statewide Standards (a)							Basin Standards (b)		Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7)						
				Tables A,B Carcinogens/ Noncarcinogens (2)	Table C Aquatic Life		Tables I,II,III (1)				Organics (12)		Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (8)		Table 2 Radionuclides	
							Aquatic Life		Agricultural Standard (3)	Domestic Water Supply (6)									
Parameter	Type (10)	PQL MDL	Method (11)		Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)			Aquatic Life	Water Supply				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Di-n-octylphthalate	SV	10	CS																
Ethylene glycol	SV		d																
Fluoranthene	SV	10	CS		3,980														
Fluorene	SV	10	CS																
Formaldehyde	SV																		
Haloethers	SV																		
Hexachlorobenzene	SV	10	CS	0.02 (13)									0.02 (13)	0.00072			0.00072		
Hexachlorobutadiene	SV	10	CS	14	90	9.3							14	0.45			0.45		
Hexachlorocyclopentadiene	SV	10	CS	49	7	5.2							49						
Hexachloroethane	SV	10	CS		980	540								1.9			1.9		
Hydrazine	SV																		
Indeno(1,2,3-cd)pyrene	SV	10	CS																
Isophorone	SV	10	CS	1,050	117,000								1,050						
Naphthalene	SV	10	CS		2,300	620													
Nitrobenzene	SV	10	CS	3.5 (13)	27,000								3.5 (13)						
Nitrophenols	SV																		
Nitrosamines	SV																		
Nitrosodibutylamine	SV		b											0.0064			0.0064		
Nitrosodiethylamine	SV		b											0.0008			0.0008		
Nitrosodimethylamine	SV		b											0.0014			0.0014		
Nitrosopyrrolidine	SV		b											0.016			0.016		
N-Nitrosodiphenylamine	SV	10	CSb											4.9			4.9		
N-Nitroso-di-n-dipropylamine	SV	10	CSb																
Pentachlorinated Ethanes	SV		b																
Pentachlorobenzene	SV		b	6 (13)									6 (13)						
Pentachlorophenol	SV	50	CS	200	9	5.7							200						
Phenanthrene	SV	10	CS																
Phenol	SV	10	CS		10,200	2,560					500	1.0							
Phthalate Esters	SV		e																
Polynuclear Aromatic Hydrocarbons	SV		b											0.0028			0.0028		

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TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

				Statewide Standards (a)							Basin Standards (b)		Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7)						
				Tables A,B Carcinogens/ Noncarcinogens (2)	Table C Aquatic Life		Tables I,II,III (1) Aquatic Life				Organics (12)		Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type (10)	PQL MDL	Method (11)		Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (6)	Aquatic Life	Water Supply				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Vinyl Chloride	SV	10	CV	2									2						
1,1,1-Trichloroethane	V	5	CV	200									200						
1,1,2,2-Tetrachloroethane	V	5	CV			2,400								0.17			0.17		
1,1,2-Trichloroethane	V	5	CV	28		9,400							28	0.60			0.60		
1,1-Dichloroethane	V	5	CV																
1,1-Dichloroethene	V	5	CV	7									7						
1,2-Dichloroethane	V	5	CV	5	118,000	20,000							5						
1,2-Dichloroethene (cis)	V		a	70									70						
1,2-Dichloroethene (total)	V	5	CV																
1,2-Dichloroethene (trans)	V		a	70									70						
1,2-Dichloropropane	V	5	CV	0.56 (13)	23,000	5,700							0.56 (13)						
1,3-Dichloropropene (cis)	V	5	CV		6,060	244													
1,3-Dichloropropene (trans)	V	5	CV		6,060	244													
2-Butanone	V	10	CV																
2-Hexanone	V	10	CV																
4-Methyl-2-pentanone	V	10	CV																
Acetone	V	10	CV																
Acrylonitrile	V		c		7,550	2,600								0.058			0.058		
Benzene	V	5	CV	5	5,300								5						
Bromodichloromethane	V	5	CV																
Bromoform	V	5	CV																
Bromomethane	V	10	CV																
Carbon Disulfide	V	5	CV																
Carbon Tetrachloride	V	5	CV	5	35,200								5						
Chlorinated Benzenes	V	10	CV/CS																
Chlorobenzene	V	5	CV/CVS	300									300						
Chloroethane	V	10	CV																
Chloroform	V	5	CV	Tot THM <100 (4)	28,900	1,240							Tot THM <100 (4)	0.19			0.19		

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TABLE 3-3 POTENTIAL CHEMICAL-SPECIFIC ARARs/TBCs (August 1, 1991)
STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (10)	PQL MDL	Method (11)	Statewide Standards (a): Tables A,B Carcinogens/ Noncarcinogens (2)	Statewide Standards (a): Table C Aquatic Life: Acute Value	Statewide Standards (a): Table C Aquatic Life: Chronic Value	Statewide Standards (a): Tables I,II,III (1) Aquatic Life: Acute Value (2)	Statewide Standards (a): Tables I,II,III (1) Aquatic Life: Chronic Value (2)	Statewide Standards (a): Tables I,II,III (1): Agricultural Standard (3)	Statewide Standards (a): Tables I,II,III (1): Domestic Water Supply (6)	Basin Standards (b): Organics (12): Aquatic Life	Basin Standards (b): Organics (12): Water Supply	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7): Tables A,B (2)	Segment 4 & 5: Table C Fish & Water Ingestion	Segment 4 & 5: Table D Radionuclide	Segment 4 & 5: Stream Segment Table (8): Acute Value	Segment 4 & 5: Stream Segment Table (8): Chronic Value	Segment 4 & 5: Table 2 Radionuclides: Woman Creek	Segment 4 & 5: Table 2 Radionuclides: Walnut Creek
Chloromethane	V	10	CV																
Dibromochloromethane	V	5	CV																
Dichloroethenes	V																		
Ethyl benzene	V	5	CV	680	32,000								680						
Ethylene dibromide	V		d																
Ethylene oxide	V																		
Halomethanes	V			100									100	0.19			0.19		
Methylene Chloride	V	5	CV																
Pyrene	V	10	CS																
Styrene	V	5	CV																
Tetrachloroethanes	V	5	CV											0.8			0.8		
Tetrachloroethene	V	5	CV	10	5,280	840							10						
Toluene	V	5	CV	2,420	17,500								2,420						
Trichloroethanes	V	5	CV																
Trichloroethene	V	5	CV	5	45,000	21,900							5						
Vinyl Acetate	V	10	CV																
Xylenes (Total)	V	5	CV																

EXPLANATION OF TABLE

CLP = Contract Laboratory Program
CDH = Colorado Department of Health
dis = dissolved
EPA = Environmental Protection Agency
pCi/l = picocuries per liter
PCB = polychlorinated biphenyl
PQL = Practical Quantitation Level
SS = species specific
TAL = Target Analyte List
THM = Total Trihalomethanes

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TIC = Tentatively Identified Compound
TVS = Table Value Standard (hardness dependent), see Table III in (a)
MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis
WQCC = Water Quality Control Commission

(1) Table I = physical and biological parameters
Table II = inorganic parameters
Table III = metal parameters
Values in Tables I, II, and III for recreational uses, cold water biota and domestic water supply are not included.
(2) In the absence of specific, numeric standards for non-naturally occurring organics, the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/WQCC or EPA
(3) All are 30-day standards except for nitrate+nitrite
(4) Total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(5) Lowest value given: dissolved or total recoverable
(6) Ammonia, sulfide, chloride, sulfate, copper, iron, manganese, and zinc are 30-day standards, all others are 1-day standards
(7) Segment 4 standards for inorganics, metals, organics, and radionuclides are TBC and Segment 5 standards are goals (TBCs)
(8) Includes Table 1: Additional Organic Chemical Standards (chronic only)
(9) See section 3.1.11 (f)(2) in (a)
(10) type abbreviations are: A=anion; B=bacteria; C=cation; I=indicator; FP=field parameter; M=metal; P= pesticide; PP=pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile
(11) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TICs in CS; c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.
(12) See Section 3.8.5 (2)(a) in (b)
(13) Standard is below (more stringent than) PQL, therefore PQL is standard.
(14) MDL for Radium 226 is 0.5; MDL for Radium 228 is 1.0

(a) CDH/WQCC, Colorado Water Quality Standards 3.1.0 (5 CCR 1002-8) 1/15/1974; amended 9/30/1989 (Envrionmental Reporter 726:1001-1020:6/1990)
(b) CDH/WQCC, Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8.0 (5 CCR 1002-8) 4/6/1981; amended 2/15/1990

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ARARs addressing contaminants in air will be included in the CMS/FS Report. In general, federal and state standards for air exist only as source- or activity-specific requirements and, accordingly, will be addressed in detail in the FS process.

3.2 THE ARAR PROCESS

3.2.1 ARARs

"Applicable requirements," as defined in 40 CFR 300.5, are "those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be 'applicable.'" "Relevant and appropriate requirements," also defined in 40 CFR 300.5, are "those clean-up standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws, that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate." The most stringent promulgated standards are applied as ARAR (Preamble to NCP, 55 FR 8741).

3.2.2 TBCs

In addition to ARARs, advisories, criteria, or guidance may be identified as TBC for a particular release. As defined in 40 CFR 300.400(g)(3), the TBC category consists of advisories, criteria, or guidance developed by EPA, other federal agencies, or states that may be useful in developing remedies. Use of TBCs is discretionary rather than mandatory, as opposed to the use of ARARs, which is mandatory.

3.2.3 ARAR Categories

In general, there are three categories of ARARs. These categories are:

1. Ambient or chemical-specific requirements.
2. Location-specific requirements.
3. Performance, design, or other action-specific requirements.

ARARs are generally considered to be dynamic in nature in that they evolve during the CERCLA site clean-up process. Initially, during the RI work plan stage, probable chemical-specific ARARs may be identified, usually based on a limited amount of data. Chemical-specific ARARs at this point have meaning only in that they may be used to establish appropriate detection limits so that data collected in the RI will be amenable for comparison to ARAR standards. Identified potential chemical-specific ARARs may be modified if they are found to be inappropriate any time in the RFI/RI process. For example, chemical-specific ARARs could be deleted based on the absence of a constituent in analytical data obtained during the investigation.

It is also appropriate to identify location-specific ARARs early in the RI process so that information may be gathered to determine if restrictions have been placed on the concentration of hazardous substances or on the conduct of an activity solely because it occurs in a specific location. As discussed in the introductory paragraph to this section, detailed location-specific ARARs will be proposed in the RFI/RI Report.

Identification of action-specific ARARs and remediation goals is part of the FS process and will be addressed in the CMS/FS report. For the proper management of investigation-derived wastes, as required in the Interagency Agreement (IAG), Attachment 2, Statement of Work, Section IV, the Department of Energy (DOE) has developed Standard Operating Procedures (SOPs) for field investigation activities. All waste generated by the various investigations conducted at Rocky Flats Plant will be managed in accordance with the SOPs. The SOPs satisfy the IAG requirement to comply with ARARs as they relate to investigation activities. Development of an overall site-wide approach to managing investigation-derived wastes is consistent with EPA policy (EPA 1991).

3.2.4 FS ARAR Requirements

Development of a preliminary list of potential chemical-specific ARARs in the RI process also allows the establishment of a list of preliminary remediation goals in the early FS process, which is essentially a tentative listing of contaminants together with initially anticipated clean-up concentrations or risk levels for each medium. Preliminary remediation goals serve to focus the development of alternatives to be considered in the detailed remedial alternative analysis, conducted later in the FS process. As more information becomes available during the RI stage, chemical-specific ARARs may become more refined as constituents are added or deleted. Once data collection is complete, revised chemical-specific ARARs may be proposed.

When the data collection is complete, it is also appropriate to refine location-specific ARARs that may affect the development of remedial alternatives. In addition, during development of remedial action alternatives at the beginning of the FS process, a preliminary consideration of action-specific ARARs will be conducted. As remedial alternatives are screened during the FS, action-specific ARARs will be identified. When a detailed analysis of the remedial alternatives is conducted, all action-specific ARARs are refined and finalized with respect to each alternative before a comparison of alternatives begins. At this point, a discussion is provided in the FS report for each remedial alternative regarding the rationale for all ARAR determinations.

3.3 REMEDIAL ACTION AND REMEDIATION GOALS

CERCLA §121 requires attainment of all ARARs. As explained in the preamble to the NCP (55 FR 8741), a remedial action must comply with the most stringent ARAR requirements, which then should ensure attainment of all other ARARs. In addition, CERCLA requires that the remedies selected meet ARARs and be protective of human health and the environment. Consequently, preliminary remediation goals based on ARARs will require modification as new information and data are collected in the RI, including the baseline risk assessment (to be conducted), when ARARs are not available or are determined to be inadequate for protection of human health and the environment.

Development of remediation goals is actually a portion of the overall development of remedial action objectives, which ultimately will define the required endpoint of the selected remedial action. As stated in the preamble to the NCP (55 FR 8713), "remedial action objectives are the more general description of what the remedial action will accomplish. Remediation goals are a subset of remedial action objectives and consist of medium-specific or operable unit-specific chemical concentrations that are protective of human health and the environment and serve as goals for the remedial action. The remedial action objectives...should specify: (1) the contaminants of concern, (2) exposure routes and receptors, and (3) an acceptable contaminant level or range of levels for each exposure medium (i.e., a preliminary remediation goal)." According to 40 CFR 300.430(e)(2)(i), "Remediation goals shall establish acceptable exposure levels that are protective of human health and the environment and shall be developed by considering the following:

- ARARs (chemical-specific)
    - Acceptable exposure levels for systemic toxicants
    - Acceptable exposure levels for known or suspected carcinogens
    - Technical limitations (e.g., detection limits)
    - Uncertainty factors
    - Other pertinent information

- Maximum Contaminant Level Goals (MCLGs) (or MCLs where MCLGs are zero) where relevant and appropriate.

- For potential carcinogens, acceptable exposure levels where multiple contaminants or multiple exposure pathways will cause exposure at ARAR levels not exceeding cumulative risk of 10^{-4}.

- Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC) where relevant and appropriate.

- A CERCLA Alternative Concentration Limit (ACL) established pursuant to CERCLA §121(d)(2)(B)(ii).

- Environmental evaluations, performed to assess specific threats to the environment."

Once a preferred remedial action alternative is formally selected, all chemical-, location-, and action-specific ARARs have also been defined in final form. If it is found that the most suitable alternative does not meet an ARAR, the NCP at 40 CFR 300.430(f)(1)(ii)(C) provides for waivers of ARARs under certain circumstances, such as technical impracticability, risk, or inconsistent application of state requirements. From this point, the alternative will become the final remedy as it is incorporated into the Record of Decision (ROD). Once the final ROD has been signed, requirements may be modified only when they are determined to be applicable or relevant and appropriate and necessary to ensure that the remedy is protective of human health and the environment [40 CFR 300.430(f)(1)(ii)].

3.4 OU5 ALLUVIAL GROUNDWATER ARARs

The potential ARARs/TBCs for groundwater listed in Table 3-1 were developed using the ARARs rationale described above and were identified by examining the following standards and criteria:

- Safe Drinking Water Act (SDWA) MCLs
- Resource Conservation and Recovery Act (RCRA) 40 CFR Part 264 Subpart F concentration limits
- Colorado Water Quality Control Commission (WQCC) Standards for Ground Water
- CWA AWQC

3.4.1 SDWA MCLs

SDWA MCLs represent the maximum permissible level of a contaminant in water that is delivered to the freeflowing outlet of the ultimate user of a public water system [40 CFR 141.2(c)]. Because groundwater at OU5 is a potential source of drinking water, MCLs are identified as ARAR. Furthermore, the NCP [40 CFR 300.430(e)] requires that, in development of remediation goals for evaluating alternatives for final remediation, the following be considered for current or potential sources of drinking water:

attainment of MCLGs or MCLs, if MCLGs are zero; and attainment of CWA AWQC, where relevant and appropriate.

Because groundwater at OU5 is a potential source of drinking water, the MCLGs (or MCLs) are relevant and appropriate for remediation goals and should be attained (note: the MCLGs are currently zero or equal to the MCLs). CWA AWQC are discussed in Section 3.4.4. It should be noted that on January 30, 1991, and June 7, 1991 (56 FR 3526 and 56 FR 26460, respectively), EPA published final rules amending MCLs and MCLGs for a number of the constituents identified in Table 3-1. These standards are effective July 30, 1992, and November 6, 1991, respectively, and will be regarded as relevant and appropriate at that time. The new MCLs (new MCLGs are zero or equal to the MCLs, except in the case of copper), are identified as potential TBCs in Table 3-1.

3.4.2 RCRA 40 CFR Part 264 Subpart F Concentration Limits

Owners or operators of facilities that treat, store, or dispose of hazardous waste must ensure that hazardous constituents listed in 6 CCR (Colorado Code of Regulations) 1007-3 and 40 CFR 261 Appendix VIII entering the groundwater from a regulated unit do not exceed concentration limits (6 CCR 1007-3 and 40 CFR 264.94) at the point of compliance in the uppermost aquifer. The concentration limits include standards for 14 compounds (these standards are equivalent to and a subset of SDWA MCLs and are identified at 40 CFR 264.94, Table 1), with background or ACLs used as the standards for the other RCRA 40 CFR Part 261 Appendix VIII constituents or 40 CFR Part 264 Appendix IX constituents. These concentration limits apply to RCRA "regulated units" subject to permitting (defined at 40 CFR 264.90 to include landfills, surface impoundments, waste piles, and land treatment units) that received RCRA hazardous waste after July 26, 1982. Although OU5 does not contain RCRA-regulated hazardous waste management units, it does contain Individual Hazardous Substance Sites (IHSSs). As a result, these RCRA 40 CFR Part 264 Subpart F regulations are considered relevant and appropriate for groundwater.

As discussed above, an ACL may be established for a hazardous constituent if it is determined that attainment of a Subpart F (Table 1) constituent standard or background standard is not necessary to ensure adequate protection of human health and the environment. Furthermore, EPA has stated that for potential drinking water sources, the Agency's preference is to set remediation levels that are the equivalent of exposure- or health-based ACLs under RCRA (EPA 1988d). It is appropriate to establish background as ARAR until it is determined through risk assessment whether attainment of background is necessary for adequate protection of human health and the environment. Accordingly, hazardous constituent background values will be applied as ARAR until such time as risk assessment information indicates some other alternative standard is necessary to ensure "protectiveness." The 40 CFR 264.94 (Table 1) standards are considered to be relevant and appropriate. Table 3-1, however, will identify SDWA MCLs rather than RCRA 40 CFR 264.94 (Table 1) standards because the RCRA standards are currently equivalent and a subset of the SDWA MCLs. ARAR background groundwater values for Subpart F will be applied from background groundwater in both the alluvial and bedrock lithologies at Rocky Flats Plant.

3.4.3 Colorado WQCC Standards for Groundwater

The Colorado WQCC has established both state-wide and classification-specific standards for the protection of state groundwaters. State-wide standards currently exist for certain radioactive materials and organic pollutants (see Section 3.11.0, 5 CCR 1002-0). These standards are not currently independently enforceable. The standards may be enforced by application under other Colorado environmental regulatory programs, though it remains questionable whether enforcement under other Colorado regulatory programs could satisfy the requirements of the NCP, 40 CFR 300.400(g)(4). Therefore, WQCC state-wide groundwater standards have been applied as TBC in Table 3-1.

The WQCC classification-specific groundwater standards do not appear to meet the NCP criteria for state ARARs. On March 15, 1991, the Colorado WQCC issued groundwater classifications and standards for groundwaters at the Rocky Flats Plant, effective April 30, 1991 (see 3.12.0, 5 CCR 1002-8). The standards assigned to alluvial groundwater address human health, secondary drinking water considerations, agriculture, dissolved solids, and surface water protection standards which include additional organics and radionuclide standards. The classifications and standards for groundwater at Rocky Flats Plant may be enforceable in the future through the State Discharge Permit System regulations anticipated to become effective in July 1992 (see 6.1.0, 5 CCR 1002-2). However, the Rocky Flats Plant site-specific standards do not meet the general applicability requirement of the NCP since no other state groundwaters have been similarly classified. Accordingly, the Rocky Flats site-specific standards have also been applied as TBC in Table 3-1.

3.4.4 CWA AWQC

The CWA AWQC are non-enforceable guidance developed under CWA Section 304, and are used by states in conjunction with designated stream segment usages to establish water quality standards for the protection of aquatic life and for the protection of human health. Criteria include levels established for drinking water and fish consumption, fish consumption only, as well as standards for the protection of aquatic life. As guidance, CWA AWQC cannot be ARAR; however, CERCLA Section 121(d) requires that CWA AWQC be considered in the development of remediation goals in the FS process, where relevant and appropriate. Relative to this work plan, AWQC in the form of drinking water and fish consumption may be considered relevant and appropriate for the groundwater medium being investigated. These AWQC will require consideration in the development of remediation goals for OU5 and, accordingly, have been identified as TBCs for alluvial groundwater.

It is important to note, however, as discussed in Section 3.4.3, that the Colorado WQCC has issued standards determined by the state to be appropriate and necessary for the protection of groundwater at the Rocky Flats Plant. Although not yet ARAR because they are not yet of general applicability, the existence of WQCC site-specific standards that reflect the specific conditions of site groundwaters may result in a determination that other standards of a broader nature are not relevant and appropriate. Consequently, it is unlikely that CWA AWQC will be considered relevant and appropriate for OU5 groundwater when remediation goals are established.

3.5 OU5 BEDROCK GROUNDWATER ARARs

OU5 bedrock groundwater ARARs were established in the same manner as those identified for alluvial groundwater. The only exceptions are the site-specific groundwater standards, as discussed in Section 3.4.3, applied as TBC to alluvial groundwater. The standards for surface water protection, namely those standards addressing additional organics and radionuclides, were not determined by the Colorado WQCC to be necessary for the bedrock aquifers at Rocky Flats Plant. Accordingly, these standards are not applied to OU5 bedrock groundwater. Table 3-1 summarizes potential ARARs/TBCs from Federal and colorado standards and criteria.

3.6 OU5 SURFACE WATER ARARs

The potential ARARs/TBCs for surface water are listed in Tables 3-2 and 3-3 and were identified by examining the following standards and criteria:

- SDWA MCLs
- Colorado WQCC Standards for Surface Water
- CWA Ambient Water Quality Criteria (AWQC)

Table 3-2 presents a summary of potential surface water ARARs/TBCs derived from Federal standards and criteria while Table 3-3 summarizes potential ARARs/TBCs from Colorado-adopted standards and criteria.

3.6.1 Safe Drinking Water Act MCLs

As discussed earlier in Section 3.4.1, the NCP requires that SDWA MCLGs be considered in the development of remediation goals, where relevant and appropriate. Moreover, in cases where groundwater or surface water is an actual or potential source of drinking water, MCLs will be ARAR. Accordingly, since OU5 surface water may ultimately contribute to sources of drinking water, SDWA MCLs and MCLGs have been identified in Table 3-2.

3.6.2 Colorado WQCC Standards for Surface Water

The Colorado WQCC has adopted both state-wide and stream segment-specific standards for the protection of state surface waters. State-wide standards exist for certain radioactive materials as well as organic standards adopted for all state sources of drinking water and areas requiring protection for aquatic life (see Section 3.1.11, 5 CCR 1002-8). These standards are consequently of general applicability. The state-wide standards are enforceable through the state's National Pollutant Discharge Elimination System (NPDES) permitting process. Having apparently met the NCP state ARAR requirements of enforceability and general applicability [40 CFR 300.400(g)(4)], the state-wide surface water standards have been applied as ARAR in Table 3-3.

Site-specific surface water standards also exist for certain metal, inorganic, organic, and radioactive constituents. Unlike the WQCC state-wide standards discussed above, these site-specific standards do not appear to satisfy the NCP requirements for state ARARs. While these standards are enforceable through the NPDES permitting process, they have been adopted only for surface waters at Rocky Flats Plant and so are not of general applicability. Also, the site-specific organic standards are based almost entirely on CWA AWQC for water and fish ingestion. These standards have not been generally applied to the surface waters of Colorado and, in fact, have only been applied to Rocky Flats Plant. Furthermore, the site-specific standards for radioactive constituents are significantly more stringent than any standards applied to other Colorado surface water bodies. Consequently, the site-specific organic chemical and radionuclide surface water standards cannot be ARAR. These standards have been applied as TBC in Table 3-3 because they reflect the degree of protectiveness determined to be necessary for Rocky Flats Plant surface waters by the Colorado WQCC.

3.6.3 CWA AWQC

As was described in Section 3.4.4, CWA AWQC are required to be considered in the development of remediation goals, where relevant and appropriate. These criteria appear to be relevant but are not appropriate because of the existence of site-specific WQCC standards that more accurately reflect the surface water protection needs of the site. CWA AWQC have been identified as TBCs in Table 3-2.

3.7 OU5 SOIL ARARs

As discussed in Section 3.1, one medium for which chemical-specific ARARs do not currently exist is soils; however, some chemical-related, action-specific requirements do exist, such as Colorado's construction standard for plutonium in soil. Action-specific requirements will be addressed in the CMS/FS process. Relative to chemical-specific ARARs, a risk assessment will be performed to determine acceptable contaminant concentrations in soils to ensure environmental "protectiveness." At this time, with respect to establishing analytical detection limits for soils, use of the method detection limits provided in the General Radiochemistry and Routine Analytical Services Protocol (GRRASP) (EG&G 1990f), which are CLP contract required quantitation limits, should enable meaningful interpretation of soil sample results.

3.8 OU5 PARAMETERS LACKING ARARs/TBCs

For any parameters to be analyzed in groundwater, surface water, or soils for which no ARARs or TBCs were found, use of the analytical methods that achieve the detection limits provided in the GRRASP (EG&G 1990f), which are CLP contract required quantitation limits, should enable meaningful interpretation of sample results. In addition, whenever a potential standard is below the GRRASP-derived detection limit, the detection limit has been used as the standard. Risk-based concentrations taken from the baseline risk assessment will be used in establishing the remediation goals for the parameters for which no potential ARARs could be identified, thus ensuring environmental "protectiveness."

4.0
DATA NEEDS AND DATA QUALITY OBJECTIVES

The primary objective of a RCRA Facility Investigation (RFI)/Remedial Investigation (RI) is to collect the data necessary to determine the nature, distribution, and migration pathways of contaminants. This information is used to support a baseline risk assessment and environmental assessment. These assessments determine the need for remediation and are used to evaluate remedial alternatives. Five general goals of an RFI/RI (U.S. EPA 1988a) are to

- Characterize site physical features
- Define contaminant sources
- Determine the nature and extent of contamination
- Describe contaminant fate and transport
- Provide a baseline risk assessment

Data quality objectives (DQOs) are qualitative and quantitative statements that describe the quality and quantity of data required by the RFI/RI (U.S. EPA 1987a). The DQO process is divided into three stages:

- Stage 1 - Identify decision types
- Stage 2 - Identify data uses/needs
- Stage 3 - Design data collection program

Through application of the DQO process, site-specific RFI/RI goals are established and data needs are identified for achieving those goals. This section of the RFI/RI work plan proceeds through the DQO process.

4.1 STAGE 1 - IDENTIFY DECISION TYPES

4.1.1 Identify and Involve Data Users

Data users are the decision makers and the primary and secondary data users. The decision makers for OU5 are the management and regulatory personnel for EG&G, the Department of Energy (DOE), the Environmental Protection Agency (EPA), and the Colorado Department of Health (CDH). EG&G's contractor will provide day-to-day management of the RI in accordance with this work plan. The decision makers have been and are involved in the OU5 DQO process through the Interagency Agreement (IAG), which specifies the minimum level of effort for the Phase I RI. The decision makers remain involved through the review and approval process specified in the IAG.

Primary data users are those individuals involved in ongoing RI activities. These are EG&G and EG&G's contractor technical staff. They will be involved in the collection and analysis of the data and in the preparation of the RI Report, including the Baseline Risk Assessment and the Environmental Assessment.

Secondary data users are those users who rely on RI outputs to support their activities. Secondary data users may include EG&G personnel working on other operable units or sitewide projects, EPA and CDH.

4.1.2 Evaluate Available Data

The historical and current conditions of each site are described in Section 2.0 of this work plan.

The following is a summary of the existing information based on the data presented in Section 2.0.

- Contamination by radioactive materials is known or suspected to exist at the Original Landfill (IHSS 115), Ash Pits (IHSS 13), C-Series Ponds (IHSS 142), in Woman Creek and in the South Interceptor Ditch.

- Metals contamination may also exist in these IHSSs, as well as in Woman Creek and the South Interceptor Ditch.

- Contamination at the IHSSs, if any, due to other substances is unknown at this time.

- The extent of contamination, if any, at the IHSSs in OU5 is unknown at this time.

- The presence of contamination is uncertain in the Surface Disturbance areas. Investigations should focus on confirmation of the presence or absence of contamination.

- There appears to be a potential for contamination from topographically or hydraulically upgradient sources (i.e., other operable units) to be present at the IHSSs.

4.1.3 Develop Conceptual Models

A generic conceptual model has been developed for the IHSSs in subsection 2.6. This model includes description of potential sources, pathways and receptors. Since very few previous studies have been conducted, the model is basic. It is not known if the sources or pathways actually exist at the IHSSs.

4.1.4 Specify Phase I RFI/RI Objectives and Data Needs

Based on existing data and the IHSS conceptual models, site-specific Phase I RFI/RI objectives/data needs associated with identifying contaminant sources and the nature and extent of contamination are shown in Table 4-1. Identification of contaminant plumes will be used at several sites to assist in identification and characterization of contaminant sources.

The objectives of the Phase I RFI/RI are:

- To characterize the physical and hydrogeologic setting of the IHSSs

- To assess the presence or absence of contamination at each site

- To characterize the nature and extent of contamination at the sites, if present

- To support the Phase I Baseline Risk Assessment and Environmental Evaluation

It is important to recognize that additional phases of investigation and risk assessment may be required at some IHSSs.

4.2 STAGE 2 - IDENTIFY DATA USES/NEEDS

Stage 2 of the DQO process defines data uses and specifies the types of data needed to meet the project objectives. The summary of Stage 2 of the DQO process is presented as Table 4-1.

4.2.1 Identify Data Uses

RI/FS data uses can be described in general purpose categories:

- Site characterization
- Health and safety
- Risk assessment
- Evaluation of alternatives
- Engineering design of alternatives
- Monitoring during remedial action
- PRP determination

TABLE 4-1

DATA QUALITY OBJECTIVES

Data Need	Sample/Analysis Method	Analytical Level[1]	Data Use
CHARACTERIZE PHYSICAL FEATURES			
• Identify extent of the Landfill, Ash Pits, and surface disturbance areas	• Review aerial photographs • Visual inspection • Logging of boreholes • Magnetometer surveys	I & II	• Site Characterization • Alternatives Evaluation
• Characterize surface water and sediments in the ponds	• Logging of sediment samples • Measurement of field parameters in water in the ponds	I & II	• Site Characterization • Alternatives Evaluation
• Characterize depressions made at the surface disturbances	• Review aerial photographs • Visual inspection • Logging of samples collected	I & II	• Site Characterization • Alternatives Evaluation
CHARACTERIZE AND DELINEATE CONTAMINANT SOURCES			
• Identify plumes (if present) at the Landfill that may lead to sources	• Soil gas survey • Boreholes and wells with analytical testing on samples, if plumes are identified	II (field GC) IV (analytical)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Identify source of pipes in Landfill	• Sewer snake survey and sampling with analytical testing	I (field) IV (analytical)	• Site Characterization
• Characterize sources (if present) at the Ash Pit areas	• Boreholes and surface samples in areas of pits and pads with analytical testing of samples	I & II (field) IV (analytical)	• Site Characterization • Alternatives Evaluation • Risk Assessment

TABLE 4-1
DATA QUALITY OBJECTIVES
(Concluded)

Data Need	Sample/Analysis Method	Analytical Level[1]	Data Use
CHARACTERIZE NATURE AND EXTENT OF CONTAMINATION			
• Characterize plumes or areas of anomalous radiation readings identified at the Landfill	• Boreholes and wells with analytical testing of samples, if plumes are identified	IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Characterize horizontal and vertical extent and nature of contamination at the Ash Pits	• Boreholes and wells with analytical testing of samples	IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Characterize surface extent of radiation at Landfill, Ash Pits and surface disturbances	• Radiation surveys	I & II	• Site Characterization • Health and Safety
• Characterize nature and extent of contamination in surface water and sediments in Woman Creek, the South Interceptor Ditch, and the Ponds	• Sediment and surface water sampling with analytical testing of the samples	II (field) IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Characterize nature and extent of contamination in alluvial groundwater	• Install and sample wells	IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment
• Assess the potential for contamination at surface disturbance areas	• Surface samples with analytical testing	IV V (radiological analyses)	• Site Characterization • Alternatives Evaluation • Risk Assessment

Note: [1] Analytical levels are described in Table 4-2.

Since this work plan describes a Phase I RI, data uses such as engineering design and monitoring during remediation (both remedial action activities) will not be considered. The data use for PRP determination is also not appropriate to this work plan. The remaining four data uses will be important in meeting the objectives identified in subsection 4.1.4.

4.2.2 Identify Data Types

Data types can be specified in broad groups initially and then divided into more specific components. For the Phase I investigation, soil, sediment, groundwater and surface water samples will be collected. In addition, radiation surveys will be conducted over most of the units. These data types will provide broad Phase I information regarding the presence or absence of contamination at the units. Selection of chemical analyses and physical testing will be based on the objectives of the Phase I program and on the past activities at the units. Data types are listed in Table 4-1 as sample/analysis methods.

4.2.3 Identify Data Quality Needs

EPA defines five levels of analytical data as follows (U.S. EPA 1987a):

- Level I - field screening or analysis using portable instruments. Results are often not compound-specific and not quantitative but results are available in real-time. It is the least costly of the analytical options.

- Level II - field analyses using more sophisticated portable analytical instruments: in some cases, the instruments may be set up in a mobile laboratory on site. There is a wide range in the quality of data that can be generated. The quality depends on the use of suitable calibration standards, reference materials, and sample preparation equipment; and the training of the operator. Results are available in real-time or several hours.

- Level III - all analyses performed in an off-site analytical laboratory. Level III analyses may or may not use Contract Laboratory Program (CLP) procedures, but do not usually utilize the validation or documentation procedures required of CLP Level IV analysis. The laboratory may or may not be a CLP laboratory.

- Level IV - CLP routine analytical services (RAS). All analyses are performed in an off-site CLP analytical laboratory following CLP protocols. Level IV is characterized by rigorous QA/QC protocols and documentation.

- Level V - analysis by non-standard methods. All analyses are performed in an off-site analytical laboratory which may or may not be a CLP laboratory. Method development or method modification may be required for specific constituents or detection limits. CLP special analytical services (SAS) are Level V.

The levels appropriate to the data need and data use have been specified in Table 4-1 for each data need. The levels as they apply to this work plan and specific analyses are presented in Table 4-2.

4.2.4 Identify Data Quantity Needs

Data quantity needs are based primarily on the quantities specified in the IAG. Additional data points have been added, where appropriate, to fill a data need. The Phase I data will be evaluated to determine the appropriate number of samples to be obtained in subsequent phases of the RI.

4.2.5 Evaluate Sampling/Analysis Options

The sampling/analysis approach for this Phase I work plan is based on a stepped, or phased approach. Screening level sampling and analysis is followed by sampling of areas of anomalous radiation readings or other areas identified during screening. Where no data are available, a grid system will be used.

4.2.6 Review PARCC Parameter Information

PARCC (precision, accuracy representativeness, completeness and comparability) parameters are indicators of data quality. Precision, accuracy and completeness goals are established for this work plan based on the analyses being performed and the analytical levels. PARCC goals are specified in the Quality Assurance Addendum (QAA) in Section 10.0 of this work plan.

4.3 STAGE 3 - DESIGN DATA COLLECTION PROGRAM

The purpose of Stage 3 of the DQO process is to design the specific data program for the Phase I Woman Creek drainage RI. To accomplish this, the elements identified in Stages 1 and 2 and the IAG are assembled, and the Sampling and Analysis Plan (SAP) is prepared. The SAP consists of a Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPjP). These two components are addressed in Sections 7.0 and 10.0 of this work plan.

TABLE 4-2

LEVEL OF ANALYSIS

Required Analytical Level	Task
Level I (Field Screens)	• Water level measurement • pH measurement • Screening for organics (OVA/HNu) • Screening for radionuclides (beta-gamma) • Temperature • Specific conductance • Screening for buried objects (magnetometer, pipe locator)
Level II (Field Analyses)	• Screening for organics (GC) • Screening for radionuclides (gross beta/gross alpha, gamma spec) • Analysis of engineering properties
Level III (Laboratory Analyses using EPA Standard Methods)	• Major ion analysis • Organics analysis • Inorganics analysis
Level IV (Laboratory Analyses using EPA CLP Methods)	• Analysis of Target Compound List (TCL) and Target Analyte List (TAL)
Level V (Nonstandard Analyses)	• Radiological analyses • Chemical analyses requiring modification of standard methods • Special Analytical Services (SAS)

Source: U.S. EPA (1987)

5.0 PHASE I RCRA FACILITY INVESTIGATION/ REMEDIAL INVESTIGATION TASKS

5.1 TASK 1 - PROJECT PLANNING

Project planning will consist of the activities necessary to initiate the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the Individual Hazardous Substance Sites (IHSSs) in the Woman Creek drainage. Activities undertaken for this project have included a review of previous investigations, historical aerial photographs, and other historical information. Results of this review are presented in Section 2.0 of this work plan. Prior to field investigations, it is necessary to complete the review of the existing data, including plant records and plans, available aerial photographs, and new data which become available after preparation of this work plan. The Interagency Agreement (IAG) also requires the submittal of several existing reports to the regulatory agencies. These reports will be assembled and reviewed during the project planning task.

Available aerial photographs will be reviewed again to assess the types and extent of activities at several of the IHSSs. A discussion of the aerial photograph review for each unit is included as the Step 1 work for each unit in Section 7.0 of this document. Available reports and plant plans will also be reviewed again. The findings of the aerial photo review and the records review will be used to finalize the field investigation program.

There are ongoing site studies at Rocky Flats of surface water and sediments, groundwater, geology (EG&G 1990b), background geochemistry (EG&G 1990c), and ambient air that may provide data that have bearing on the investigations in Woman Creek. These data will be compiled and evaluated during Task 1. Data from investigations at overlapping OUs will also be reviewed. For example, the need for additional surface water and sediment sampling locations will be dependent on the locations of ongoing sampling and the scope of analyses. If available data from ongoing investigations meet the requirements of the Phase I sampling and analysis plan, the samples proposed in Section 7.0 need not be collected again.

Other project-related documents are currently being prepared. The Sampling and Analysis Plan (SAP), which includes the site-wide Quality Assurance Project Plan (QAPjP) and Standard Operating Procedures (SOP) for field activities, is currently being completed by EG&G. The Health and Safety Plan (HSP) is also being completed by EG&G. The Field Sampling Plan (FSP) is included as Section 7.0 of this document. The Phase I FSP will be revised as necessary based on the findings of the photo and records review.

5.2 TASK 2 - COMMUNITY RELATIONS

The information contained in this section is summarized from DOE (1990b). In accordance with the IAG, dated January 22, 1991, the Communications Department at Rocky Flats is developing a plant-wide Community Relations Plan (CRP) to develop an interactive relationship with the public relating to environmental restoration activities. A Draft Community Relations Survey Plan has been completed and forwarded to the Environmental Protection Agency (EPA), the Colorado Department of Health (CDH), and the public for review. This plan specifies activities planned to complete the Environmental Restoration (ER) Program CRP, including plans for community interviews. The draft CRP was completed in September and the final CRP in November 1990, in accordance with the IAG schedules. Accordingly, a site-specific CRP is not required for Operable Unit Number 5 (OU5). The ER program community relations activities include participation by plant representatives in informational workshops, meetings of the Rocky Flats Environmental Monitoring Council, briefings of the public on proposed remedial action plans, and meetings to solicit public comment on various ER program plans and actions.

The Communications Department is continuing other public information efforts to keep the public informed on ER activities and other issues related to plant operations. A Speakers Bureau program sends speakers to civic groups and educational organizations, while a public tour program allows the public to visit Rocky Flats. An Outreach Program is also in place in which plant officials visit elected officials, the news media, and business and civic organizations to further discuss issues related to Rocky Flats and ER activities. The Communications Department receives numerous public inquiries which are answered through telephone conversations or by sending written informational materials to the requestor.

5.3 TASK 3 - FIELD INVESTIGATION

Phase I field investigations will be conducted at the IHSSs in Woman Creek to collect samples and data concerning the nature and extent of contamination, if any, at each unit. The data and sample results will be used to support the Phase I Environmental Evaluation and Phase I Baseline Risk Assessment, as well as meet the objectives and data needs described in Section 4.0 of this work plan. It is important to recognize that additional phases of investigation and risk assessment may be required at some IHSSs prior to Feasibility Studies.

Three types of activities will be performed during the Phase I field investigation: screening activities, sampling activities, and monitoring well installation. Screening activities include visual inspections, radiological surveys, magnetometer surveys and soil gas surveys. Sampling activities include surface soil sampling, subsurface sampling using test borings, surface water sampling, and sediment sampling. Monitoring wells will be installed and sampled at specified locations and in some test borings.

Ten IHSSs and two additional areas have been included in OU5 in the Woman Creek drainage. These IHSSs have been grouped into four groups based on the historical use of the units and the physical similarities of the units. Because of the diverse nature of the IHSS groups, the Phase I field investigations for each group will be different. The general discussion of field activities planned for each IHSS group, based on the IAG, is given below. Specific field activities are described in the Phase I FSP in Section 7.0 of this work plan.

5.3.1 IHSS 115 - Original Landfill

Screening activities at the Original Landfill will consist of a review of the gamma radiation survey recently completed and completion of a soil gas survey and magnetometer survey. Sampling will include subsurface sampling in borings and sediment and surface water sampling adjacent to the unit. Wells will be installed and sampled downgradient of the unit and in selected soil borings if a plume is encountered. An additional activity at the unit will be a study of the pipes protruding from the landfill and sampling of effluent from the pipes, if present.

5.3.2 IHSS 133.1-6 - Ash Pits 1-4, Incinerator, and Concrete Wash Pad

Aerial photographs will be reviewed to identify the extent of the disposal areas at the IHSS 133 sites. A radiological survey and magnetometer survey will be the screening activities conducted at IHSS 133. Surface soil samples will be collected from the locations that have high radiation concentrations identified during the radiological survey. Subsurface samples will also be collected from borings in the IHSS 133 areas. Three monitoring wells will be installed downgradient of the units and sampled.

5.3.3 IHSS 142 - Detention Ponds - C-Series

There will not be any screening activities at the two C-Series ponds. Surface water samples will be collected from several locations in each pond. Sediment samples will be collected in the ponds, as well as along the entire Woman Creek drainage within the Rocky Flats Plant. Sediment samples will also be collected in the South Interceptor Ditch (SID). Two monitoring wells will be installed and sampled in the alluvium downgradient of each of the dams at Ponds C-1 and C-2.

5.3.4 IHSS 209 - Surface Disturbance Southeast of Building 881, Surface Disturbance West of IHSS 209, and Surface Disturbances South of the Ash Pits

Visual inspections of the surface disturbance areas and reviews of historical use information pertaining to these sites will be completed prior to screening and sampling activities. A radiological survey will be completed at each area. Surface soil samples will be collected from the three excavations at IHSS 209 and from the north-south excavation at the surface disturbance south of the Ash Pits. A sediment sample and water sample (if water is present) will be collected from each of the former pond areas at IHSS 209. Surface and subsurface samples will be collected from borings in the parallel excavations and the east and west areas at the surface disturbance south of the Ash Pits. Surface samples will be collected at the surface disturbance west of IHSS 209.

5.4 TASK 4 - SAMPLE ANALYSIS AND DATA VALIDATION

Samples collected during the Phase I field investigation will be analyzed for the parameters specified in the IAG, as a minimum, as described in subsection 7.3. Analytical procedures will be completed in accordance with the ER Program QAPjP. Project-specific quality assurance (QA) requirements are included in the Quality Assurance Addendum (QAA), Section 10.0 of this work plan. Subsection 7.3 of this work plan specifies Phase I analytical requirements, as well as sample containers, preservation and holding times, and field quality control (QC) requirements. Samples collected for this work plan will be analyzed by a Rocky Flats Plant (RFP) contract laboratory.

Phase I data will be reviewed and validated according to the data validation guidelines in the QAPjP and the Data Validation Functional Guidelines (EG&G 1990a). These documents state that the results of data review and validation activities will be documented in data validation reports.

5.5 TASK 5 - DATA EVALUATION

Data collected during the Phase I Woman Creek drainage RI will be incorporated into the existing database with data from investigations at other OUs. The data will be used to better define site characteristics, source characteristics, the nature and extent of contamination, to support the baseline risk assessment and environmental evaluation, and to evaluate potential remedial alternatives.

5.5.1 Site Characterization

Geologic and hydrogeologic data will be used to develop site maps and cross sections. Geologic data will be used to evaluate the stratigraphy of the alluvium and colluvium at each site and to determine the depth to bedrock and the bedrock type. Geologic data from boreholes will provide information on the size and depths of the Landfill and Ash Pits.

Hydrogeologic data will be used to characterize the unconfined aquifer at the sites. These data will include information about the following:

- Hydrostratigraphic characteristics of units present
- Aquifer hydraulic parameters

- Hydraulic gradients
- Water table depth and configuration

To characterize the general groundwater flow regime within and adjacent to the IHSSs, groundwater flow modeling at an appropriate scale will be conducted. This flow modeling will initially consist of a single modeling project designed to include the IHSSs within OU5 and integrate consistently with sitewide groundwater flow modeling. The initial flow modeling will be used to construct flow paths from the IHSSs and to determine requirements for more detailed flow and transport modeling. Detailed flow and transport modeling will be done at the IHSS level as necessary.

To characterize the general surface water system of OU5, a regional scale surface water flow and transport model will be developed. This model will include the Woman Creek segments that exist on RFP site. The model will be integrated with pond models to simulate the Woman Creek system. The regional model may be expanded to include off-site segments as necessary. Where required, IHSS-specific flow and transport models will be developed and integrated to the regional scale model.

Data collected during surface water and sediment sampling, including background sampling, will be used to characterize Woman Creek, the SID, and the C-Series ponds.

5.5.2 Source Characterization

The data collected during the Phase I RI will be evaluated to identify potential sources of contamination at the IHSSs. Potential sources include wastes disposed at the sites and off-site sources located topographically and/or hydraulically upgradient of the sites. Analytical data from soil and sediment sampling at the sites will be used to characterize the nature, lateral and vertical extent, and volume of source materials, if present.

5.5.3 Nature and Extent of Contamination

Graphical and, where appropriate, statistical methods will be used to identify chemical and radioactive contaminants present in the soil, sediment, surface water, and groundwater and to estimate the concentrations and distributions of the contaminants. Results of sampling will be compared with results of the ongoing background geochemical characterization to asses if chemical concentrations are above background levels. Products of this analysis may include isopleth maps, cross sections and profiles, chemical tables, and statistical results.

5.6 TASK 6 - PHASE I BASELINE RISK ASSESSMENT

Using existing data and data collected during the tasks described above, a Phase I baseline risk assessment will be prepared for OU5 to evaluate the potential risks to public health and the environment in the absence of remedial action. The Phase I baseline risk assessment will provide the basis for determining whether additional investigations are necessary at the IHSSs and whether remedial actions are necessary.

The risk assessment will be accomplished in five general steps:

- Identification of chemicals of concern
- Exposure assessment
- Toxicity assessment
- Risk characterization
- Presentation of uncertainties and limitations of the analysis

The Phase I risk assessment will address the potential public health and environmental impacts associated with the site under the no-action alternative (no remedial action taken) based on the data available. This assessment will aid in the preliminary screening site remedies based on the contaminants of concern and the environmental media associated with potential risks to public health and the environment.

The objectives and description of work for each risk assessment step are described in detail in the Baseline Risk Assessment Plan for OU5, Section 8.0 of this work plan. The Environmental Evaluation Work Plan for OU5 is Section 9.0 of this work plan.

5.7 TASK 7 - DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

Remedial Alternatives Development/Screening

This section identifies potential technologies applicable to the remediation of contaminated soils, wastes, and groundwater at OU5. The identified technologies are based on the preliminary site characterization developed in Section 2.0. Identification and screening of technologies, assembling an initial screening of alternatives, and identification of potential interim remedial actions will be conducted while the RFI/RI investigation is being conducted. However, the investigation of this operable unit is in its early stages and thus remedial alternatives are only briefly reviewed in this section. A more detailed evaluation of the remedial alternatives of each IHSS will be performed as more data are collected. It is important to recognize that additional phases of investigation may be required at some IHSSs prior to final screening of alternatives.

The process that will be employed to develop and evaluate alternatives for Operable Unit Number 5 is similar to the EPA Superfund process for selecting remedial alternatives. The Superfund Comprehensive Environmental Recovery, Compensation and Liability Act of 1980 (CERCLA) process is described in detail in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (U.S. EPA 1988a). The CERCLA process was adopted because it specifies in the greatest detail the steps that should be followed for selection of remedial alternatives. In addition, the IAG requires general compliance with both Resource Conservation and Recovery Act (RCRA) and CERCLA guidance.

The steps followed to develop remediation alternatives for the Original Landfill (IHSS 115), Ash Pits 1-4 (IHSSs 133.1, 133.2, 133.3, 133.4), Incinerator (IHSS 133.5), Concrete Wash Pad (IHSS 133.6), Ponds C-1 and C-2 (IHSS 142.10 and 142.11) and Surface Disturbance (IHSS 209) areas are:

- Develop site remedial action objectives based on: chemical- and radionuclide-specific standards (when available); site-specific, risk-related factors; and other criteria, as appropriate.

- Develop preliminary risk-based remedial action goals for affected media. Preliminary remedial action goals will be applied as performance objectives (along with chemical-specific Applicable or Relevant and Appropriate Requirements [ARARs]) for evaluating the effectiveness of specific technology processes identified as candidate components of viable remedial action alternatives. Consistent with the National Contingency Plan (NCP), preliminary remediation goals will be established at a 1×10^{-6} excess cancer risk point of departure and at other intervals within the 1×10^{-4} to 1×10^{-6} decision range. As the Feasibility Study evolves, preliminary remediation goals may be revised to a different risk level based on consideration of appropriate factors including, but not limited to: exposure, uncertainty, and technical issues.

- Develop a list of general types of actions appropriate for the IHSS areas constituting OU5 (such as containment, treatment, and/or removal) that may be taken to satisfy the objectives defined in the previous step. These general types or classes of action are generally referred to as "general response actions" in EPA guidance.

- Identify and screen technology groups for each general response action. For example, the general response action for containment can be further defined to include the in situ stabilization of contaminants in a form that is less mobile or immobile in the environment. Other containment alternatives could consist of groundwater barriers, such as slurry walls. Screening will eliminate those groups that are not technically feasible at the site.

- Identify and evaluate process options for each technology group to select a representative process for each group under consideration. Although specific process options are selected for alternative development and evaluation, these processes are intended to represent the broader range of options within a general technology group. For example, a soil bentonite slurry wall may be selected as representative of vertical barriers and would be used for technical and cost comparisons.

- Assemble the selected representative technologies into potential interim response actions for each IHSS, if appropriate.

- Assemble the selected representative technologies into site closure and corrective action alternatives for the IHSS areas comprising OU5 that represent a range of treatment and containment combinations, as appropriate.

- Screen the assembled alternatives against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Because the purpose of the screening evaluation is to reduce the number of alternatives that will undergo a thorough and extensive analysis, alternatives will be evaluated in less detail than subsequent evaluations.

"Effectiveness" is an evaluation of the protectiveness of human health and the environment achieved by a remedial alternative action during construction and implementation and after the response objectives have been met. Evaluation of effectiveness in the short term is based on protection of the community and workers, impacts to the environment, and the time required to meet remedial response objectives. Long-term evaluation of effectiveness addresses the risk remaining to human health and the environment and is based on the percent permanent destruction of, the decreased mobility of, and/or the reduction in volume of toxic compounds achieved after response objectives have been met.

"Implementability" is a measure of both the technical and administrative feasibility of constructing and operating and maintaining a remedial action alternative. It is used during screening to evaluate the combinations of process options with respect to site-specific conditions. "Technical feasibility" refers to the ability to construct, reliably operate, and comply with action-specific (technology-specific) requirements in order to complete the remedial action. "Administrative feasibility" refers to the ability to obtain required permits and approvals; to obtain the necessary services and capacity for treatment, storage, and disposal of hazardous wastes; and to obtain essential equipment and technical expertise.

Cost estimates for screening will be derived from cost curves, generic unit costs, vendor information, conventional cost estimating guides, and prior estimates made for Rocky Flats and similar sites, with modifications made for Rocky Flats Plant conditions. Absolute cost accuracy is not necessary, but cost estimates should have the same relative accuracy for comparison and screening. The cost estimating procedures used during screening are similar to those that will be used during the later, detailed alternatives analysis. The later, detailed analysis, however, will receive more in-depth and detailed cost estimates for the components of each alternative. The screening cost estimates will include capital, operating, and maintenance costs. The operating and maintenance costs will be calculated for the lifetime of the treatment unit operation at the site. Present-worth cost analysis will be used for alternatives to make the costs for the various alternatives comparable.

Alternatives with the most favorable results from the composite evaluation will be retained for further scrutiny during the detailed analysis. Not more than 10 alternatives will be retained for detailed analysis (including containment and no-action alternatives). At that time, it may be determined that additional site-specific information or technology-specific treatability studies are necessary for an objective detailed analysis. Also, it will be necessary to identify and verify the action-specific ARARs that each respective alternative will be required to meet.

For the Phase I RFI/RI work plan, the appropriate level of alternatives analysis is the listing of general response actions most applicable to the type of site under investigation. General response actions are defined as those broad classes of actions that may satisfy the objectives for remediation defined for OU5. Table 5-1 provides a list and description of general response actions and typical technologies associated with remediating soils, groundwater, sediments, and surface water. Table 5-1 also includes a general statement regarding the applicability of the general response action to potential exposure pathways. Not all of the alternative response actions and typical technologies listed may be appropriate for the IHSSs comprising OU5. Some will be discarded during the screening of alternatives.

The response actions outlined in Table 5-1 must be applied to the potential exposure pathways that will be identified for OU5. The response actions can be capable of providing control over all or some of the potential pathways. Partially effective response actions can be combined to form complementary sets of response actions that provide control over all pathways.

TABLE 5-1

GENERAL RESPONSE ACTIONS, TYPICAL ASSOCIATED REMEDIAL TECHNOLOGIES, AND EVALUATION

General Response Action	Description	Applicability of General Response Typical Technologies	Action to Potential Pathways
No Action	No remedial action taken at site.	Some monitoring and analyses may be performed.	National Contingency Plan requires consideration of no action as an alternative. Would not address potential pathways, although existing access restriction would continue to control onsite contact.
Access and use restrictions	Permanent prevention of entry into contaminated area of site. Control of land use.	Site security; fencing; deed use restrictions; warning signs.	Could control onsite exposure and reduce potential for offsite exposure. Site security fence and some signs are in place. Additional short-term or long-term access restriction would likely be part of most remedial actions.
Containment	In-place actions taken to prevent migration of contaminants.	Capping; groundwater containment barriers; soil stabilization; enhanced vegetation.	If applied to source, could be used to control all pathways. If applied to transport media, could be used to mitigate past releases (except air).
Pumping	Transfer of accumulated subsurface or surface contaminated water, usually to treatment and disposal.	Groundwater pumping; leachate collection; liquid removal from surface impoundments.	Applicable to leachate removal prior to in situ treatment or waste removal. Applicable removal of contaminated groundwater and bulk liquids (for example, from buried drums).
Removal	Excavation and transport of primarily nonaqueous contaminated material from area of concern to treatment or disposal area.	Excavation and transfer of drums, soils, sediments, wastes, contaminated structures.	If applied to source, could be used to control all pathways. If applied to transport media, will control corresponding pathway. Must be used with treatment or disposal response actions to be effective.

TABLE 5-1
GENERAL RESPONSE ACTIONS, TYPICAL ASSOCIATED REMEDIAL TECHNOLOGIES, AND EVALUATION
(Concluded)

General Response Action	Description	Applicability of General Response Typical Technologies	Action to Potential Pathways
Treatment	Application of technology to change the physical or chemical characteristics of the contaminated material. Applied to material that has been removed.	Solidification; biological, chemical, and physical treatment.	Applied to removed source material; could be used to control all pathways. Applied to removed transport media, could control air, surface water, groundwater, and sediment pathways.
In Situ Treatment	Application of technologies in situ to change the in-place physical or chemical characteristics of contaminated material.	In situ vitrification; bioremediation.	Applied to source, could be used to control all pathways. Applied to transport media, could be used to control corresponding pathways.
Storage	Temporary stockpiling of removed material in a storage area or facility prior to treatment or disposal.	Temporary storage structures.	May be useful as a means to implement removal actions, but definition would not be considered a final action for pathways.
Disposal	Final placement of removed contaminated material or treatment residue in a permanent storage facility.	Permitted landfill; repositories.	With source removal, could be used to control all pathways. With removal of contaminated transport media, could be used to control corresponding pathway (except air).
Monitoring	Short- and/or long-term monitoring is implemented to assess site conditions and contamination levels.	Sediment, soil, surface water, and groundwater sampling and analysis.	RCRA requires post-closure monitoring to assess performance of closure and corrective action implementation.

In general terms, potential human exposure may be avoided by prevention of contaminant release, transport, and/or contact. Thus, application of the response actions may be considered at three different points in each potential exposure pathway: (1) at the point where the contaminant could be released from the source, (2) in the transport medium, and (3) at the point where the contact could occur with the released contaminant.

The existing data regarding the site hydrogeologic characteristics and potential soil and groundwater contamination are not sufficient for implementing the screening process. The IAG and this work plan indicate that the following information will be collected during the Phase I RFI/RI for the characterization of the source and groundwater contaminants and for the preliminary screening of alternatives:

- Describe contaminant fate and transport
  - Collect and analyze soil and groundwater samples below and hydraulically downgradient of potential release areas to evaluate contaminant spread
  - Collect groundwater samples at selected locations to evaluate contaminant distribution
  - Collect and analyze surface water and sediment samples at the Detention Ponds
  - Collect sediment/surface soil samples in the creek/stream and Interceptor Ditch beds
  - Collect surface soil samples at the Ash Pits, Incinerator, and around the Concrete Wash Pad
  - Describe and characterize hydrogeology beneath all IHSS areas

- Site physical characterization
  - Groundwater flow regime within the unconfined aquifer
  - Soil types and general engineering properties
  - Surface water flow regime
  - Depth to groundwater and saturated thickness

These data will provide for a comparative evaluation of the technologies with respect to implementability, effectiveness, and cost, and will allow for informed decisions to be made with respect to the selection of preferred technologies. The FSP (Section 7.0) describes the methodology that will be followed to obtain the required information.

<u>Detailed Analysis of Remedial Alternatives</u>

It is unlikely that sufficient data will be generated during the Phase I investigation to allow a detailed analysis of remedial alternatives. The detailed analysis of each alternative will be performed when sufficient data is generated during the remedial selection process. The detailed analysis is not a decision-making process, but it is the process of analyzing and comparing relevant information in order to select a remedial action. Each alternative will be assessed against nine evaluation criteria, and the assessments will be compared to identify the key tradeoffs among the alternatives. Assessment against the nine evaluation criteria is necessary for the Feasibility Study (FS) and the subsequent Record of Decision (ROD)/Corrective Action Decision (CAD) to comply with the CERCLA/RCRA ARARs. The nine specific evaluation criteria are:

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

These criteria are described in the CERCLA EPA guidance document (U.S. EPA 1988a). The initial two criteria are considered threshold criteria because these alternatives must be satisfied before further consideration of the remaining criteria. The next five criteria are considered the primary criteria on which the analysis is based. The final two criteria, state and community acceptance, are addressed during the final decision-making process after completion of the Corrective Measure Study/Feasibility Study (CMS/FS).

5.8 TASK 8 - TREATABILITY STUDIES

This task includes efforts to provide technical support in the form of bench-scale treatability tests to the Rocky Flats Plant ER Program in the event that treatability studies are necessary or appropriate to support the OU5 RFI/RI. EG&G has prepared a site-wide Treatability Studies Plan (EG&G 1991f) which addresses this Task. The site-wide studies will be utilized as appropriate for OU5.

Treatability studies are conducted primarily to: (1) provide sufficient data to allow treatment alternatives to be fully developed and evaluated during the detailed analysis, and to support the design of a selected remedial alternative; and (2) reduce cost and performance uncertainties for treatment alternatives to acceptable levels so that a remedy can be selected. Treatability study requirements are developed during the development and screening of remedial alternatives (subsection 5.7) and include all available data from the current study as well as prior studies.

Numerous technologies that appear to be potentially applicable for treating OU5 will be screened for treatability testing. The technologies selected for screening will be limited to those already commercially established or which have demonstrated potential for processing spent solvents, radionuclides, oils, and similar contaminants. Additionally, the technologies considered will be required to be readily implementable (i.e., standard design package units available) within a short time frame. Innovative and alternative technologies not meeting the above requirements will not be considered.

Depending on the hydraulic properties of the unconfined aquifer considered for remediation, it may be feasible to collect groundwater for treatment above ground. In that case, the following technologies have been identified for potential testing:

- Chemical Oxidation of Organics - Chemical oxidation is used to degrade hazardous organic materials to less toxic compounds. Oxidation systems, particularly those using ultraviolet (UV) light, ozone, and hydrogen peroxide, are powerful tools for treating a wide variety of common organic environmental contaminants. Disadvantages are similar to those for inorganic oxidation reduction: potential nontarget organics and inorganics can produce undesirable side products and increase oxidant requirements.

- Granular Activated Carbon (GAC) Adsorption of Organics - GAC adsorption is the most fully developed and widely used technology for treating groundwater contaminated with organics. It is effective for the removal of a wide range of organics from aqueous waste streams. Bench-scale testing consists of running a series of descriptive tests to determine isotherms for the groundwater contaminants. GAC is typically regenerated with a thermal process, and the regeneration process can be performed at either off-site or on-site facilities.

- Reverse Osmosis - Reverse osmosis processes involve the use of semipermeable membranes. By applying water pressure greater than the osmotic pressure to one side of the membrane, water is passed through the membrane while particulate, salts, and high molecular weight organics are retained. However, the retained, highly concentrated solution (retentate) contains dissolved salts as well as the target contaminants, and requires further treatment or disposal.

- Air Stripping - Air stripping is a proven technology for removal of volatile and semivolatile contaminants from water. This process involves the transfer of contaminants from a contaminated liquid phase to a vapor phase by passing the two countercurrent streams through a packed tower. Air emission treatment is generally required, with vapor phase activated-carbon systems being the most commonly used process for this purpose, though other alternatives, such as oxidation and incineration, exist. The vapor phase treatment unit is generally costly.

- Distillation - Distillation is a process that involves separating compounds by means of their boiling point characteristics. The primary use of distillation is for reclaiming spent solvents from industrial processes, and it is generally applicable only to rather concentrated solutions. The process can be used to separate various volatile compounds or to separate mixtures of organics into light and heavy fractions. The light fraction can usually be recycled or used as a boiler feed, while the heavy fraction requires further treatment.

- Biological Reactors - Biological reactors utilize microorganisms to remove organic contaminants from the water. Most organic contaminants can be biologically degraded by introducing the appropriate microorganisms. High concentrations of some organics and the presence of metals may prove toxic to the organisms, however, and pretreatment may be required. Several types of aerobic reactors exist, including activated sludge systems, trickling filters, rotating biological contactors, and immobilized cell reactors. In general, these methods generate large amounts of sludge, requiring disposal.

- Sorption of Radionuclides - Sorption of inorganics, metals, and radionuclides is a standard technique for removal and concentration of these contaminants from wastewater. Common and proven sorption processes include ion exchange and GAC, while less-proven techniques involve the use of activated alumina, bone char, and proprietary sorption media. The sorption media are generally chemically regenerated, which results in a concentrated side stream requiring further treatment or disposal. Ion exchange and GAC sorbents are addressed separately elsewhere in this subsection, while the use of activated alumina and bone char are discussed below.

  Activated alumina is a porous form of aluminum oxide with a large surface area. For removal of aqueous contaminants, activated alumina is typically used in a column similar to that for ion exchange. It has been proven successful in the removal of arsenic and fluoride from groundwater (Rubel 1980). More recently, activated alumina has shown promise in absorbing plutonium from a low-level wastewater effluent at the Hanford Site (Barney et al. 1989). In the same study, plutonium adsorption on bone char was the most rapid and gave the highest decontamination factors. Waste-stream-specific laboratory testing would provide valuable information on the suitability of these sorbents for low-level radionuclide removal.

- Ion Exchange of Radionuclides - Ion exchange processes are used for a wide range of water treatment application, including commonly recognized systems such as demineralizers and water softeners. The goal of an ion exchange system is to remove undesirable ions of a certain type(s) from a solution and replace them with more acceptable ions. Radionuclides are commonly removed from waste streams at nuclear facilities using ion exchange.

  Ion exchange resins, particularly anion exchange resins, have been used to recover uranium from mine run-off water for many years. Extensive studies on the laboratory scale report removal of uranium from natural waters as high as 99 percent (Sorg 1988). A small full-scale ion exchange system was capable of removing uranium from drinking water supplies to as low as $1 \mu g/l$ (Jelinek and Sorg 1988). Ion exchange resins are typically rechargeable; however, the resins used in radioactive applications are generally only used once and are then disposed of as solid waste. Although published information in the removal of plutonium from natural waters by ion exchange has not been found, there is indication that ionized plutonium is removable using this technology (Marston 1990).

In cases where collection of groundwater is not feasible or practical, the following technologies have been identified for potential testing:

- In Situ Biological Treatment - Depending on the effective porosity of the soils, in situ biological treatment may be feasible. In situ biological treatment of groundwater involves the stimulation of biological growth in the contaminated zone in order to reduce the contaminant concentrations. Microorganisms that can use some or all of the contaminants as substrates will normally exist in a contaminated environment. The microorganisms are stimulated to increase their biological growth and consumption of contaminants through addition of essential nutrients. Aerobic treatment systems also require the introduction of oxygen. In situ treatment is dependent on geological and hydrological conditions. The process is relatively inexpensive.

- Vacuum Extraction - Volatile contaminants can be removed from soil using vacuum extraction, which is an in situ treatment technology that involves the air stripping of contaminants by inducing a vapor flow through the soil. Since this technology involves the transfer of contaminants to the vapor, air emission treatment is generally required. The efficiency of the process is highly dependent on geologic conditions, and would tend to be ineffective in low-permeability materials.

In cases where contaminants are entrained in soils, the soil (such as surface soil) is accessible, and the contamination is of limited areal extent, the following technologies have been identified for potential testing:

- Solidification/Stabilization - Solidification is a process in which contaminants are mechanically bound to solidification agents, reducing their mobility. This produces a solid matrix of waste with high structural integrity. Stabilization usually involves the addition of a chemical reagent to react with the contaminant, producing a less mobile or less toxic compound. Solidification and stabilization are frequently used together and are a well-established method for reducing the mobility and toxicity of hazardous wastes. This process generates large volumes of solidified materials requiring disposal.

- Vitrification - The vitrification process involves heating the waste matrix to a very high temperature and either combining the matrix with molten glass or heating the matrix until it melts. Once cooled, the molten mass solidifies into a stable, noncrystalline solid resistant to leaching of inorganic, metal, and radionuclide contaminants. Organic components are destroyed by pyrolysis. The process can be conducted either in situ or off site; however, the process is generally expensive.

- Physical Separation - Soil contaminants are often found to be associated with a particular size fraction of soils, most often fine particles. In these cases, fractionation of the soil based on particle size can be an effective means of reducing the volume of the material that requires further treatment. The processes used for soil size fractionation include screening, classification, flotation, and gravity concentration.

- Soil Washing - Soil washing is based on the principle of contaminant removal from soil by washing with two liquid solutions. Washing agents include water, acids, solvents, surfactants, and chelators. With the selection of appropriate washing solutions, soil washing technology can potentially be used to remove organics, inorganics, metals, and radionuclides. The wash solution containing the contaminants will require treatment and/or disposal.

5.9 TASK 9 - REMEDIAL INVESTIGATION REPORT

An RI report will be prepared summarizing the data obtained during the Phase I field work and data collected from previous and ongoing investigations. This report will:

- Describe in detail the field activities that serve as a basis for the RI report. This will include any deviations from the work plan that occurred during implementation of the field investigation.

- Discuss site physical conditions. This discussion will include surface features, meteorology, surface water hydrology, surficial and subsurface geology, groundwater hydrology, demography and land use, and ecology.

- Present a Preliminary Site Characterization based on all RFI/RI activities at OU5 and characterize the nature and extent of contamination. The media to be addressed will include contaminant sources, soils, sediments, groundwater, surface water, air, and biota.

- Discuss contaminant fate and transport. This discussion will include potential migration routes, contaminant persistence, chemical attenuation processes and potential receptors.

- Present a baseline risk assessment. The risk assessment will include human health and environmental evaluations.

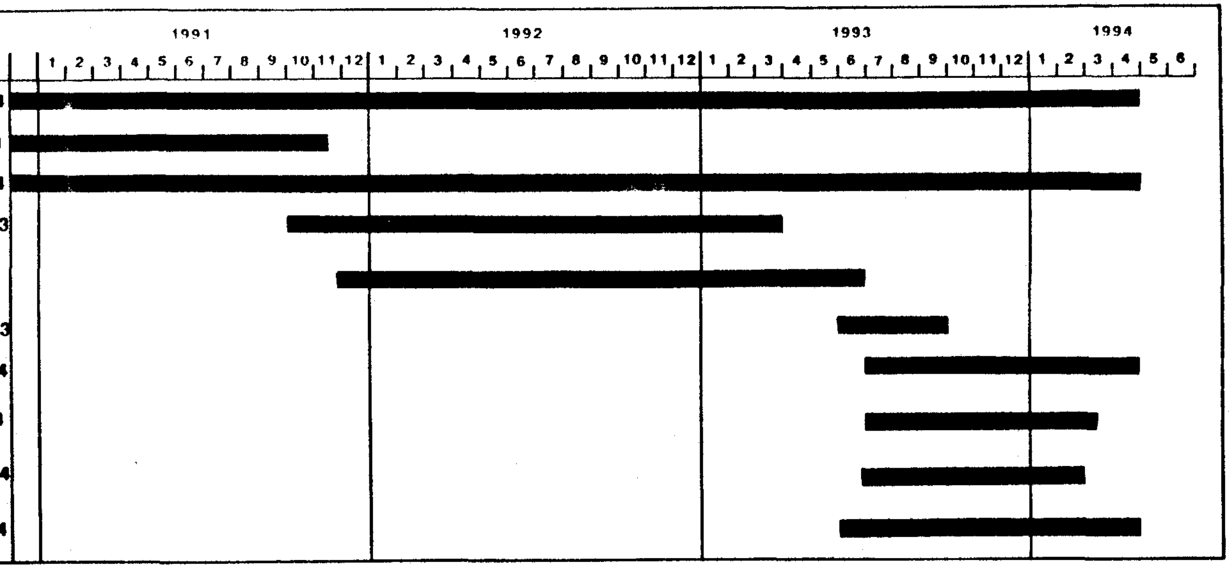
- Present a summary of the findings and conclusions.

- Identify data gaps and work to be performed for the Phase II investigation.

6.0
SCHEDULE

The schedule for conducting the Phase I Remedial Investigation is summarized in Figure 6-1. Dates shown are from the Interagency Agreement (IAG), dated January 22, 1991. According to the schedule, approximately 3 years will elapse from the time this work plan is finalized until the Phase I Remedial Investigation Report is issued.

ACTIVITY	DATES START	DATES FINISH
PROJECT MANAGEMENT	4 Sep,90	3 May,94
TASK 1 - PROJECT PLANNING	4 Sep,90	6 Nov,91
TASK 2 - COMMUNITY RELATIONS	4 Sep,90	3 May,94
TASK 3 - FIELD INVESTIGATION	2 Oct,91	30 Mar,93
TASK 4 - SAMPLE ANALYSIS & DATA VALIDATION	14 Nov,91	1 Jul,93
TASK 5 - DATA EVALUATION	4 Jun,93	29 Sep,93
TASK 6 - BASELINE RISK ASSESSMENT	25 Jun,93	3 May,94
TASK 7 - DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES	25 Jun,93	2 Mar,94
TASK 8 - TREATABILITY STUDIES	25 Jun,93	24 Feb,94
TASK 9 - PHASE I REMEDIAL INVESTIGATION REPORT	4 Jun,93	3 May,94



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

PHASE I RFI/RI SCHEDULE

Figure 6-1 MARCH 1991

7.0
PHASE I FIELD SAMPLING PLAN (FSP)

7.1 BACKGROUND AND SAMPLING RATIONALE

7.1.1 Background

The objectives of the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) are:

- To characterize the physical and hydrogeologic setting of the Individual Hazardous Substance Sites (IHSSs)
- To assess the presence or absence of contamination at each site
- To characterize the nature and extent of contamination at the sites, if present
- To support the Phase I Baseline Risk Assessment and Environmental Evaluation

Within these broad objectives, site-specific data needs have been identified in Section 4.0. The purpose of this section of the work plan is to provide a Field Sampling Plan (FSP) that will address data needs and data quality objectives. The FSP developed in this section is based on the requirements of the IAG Statement of Work for OU5, and the data needs developed in Section 4.0. It is important to recognize that additional phases of investigation and risk assessment may be required at some IHSSs prior to feasibility studies.

Generally, only limited information is available concerning the IHSSs in Operable Unit Number 5 (OU5) since there have been no previous field investigations of these sites. Available information includes aerial photographs, site histories, and some analytical data for samples collected near the IHSSs. Little information exists specific to the physical characteristics of the sites or to the nature and extent of the contamination, if present.

One of the objectives of the RFI/RI is to assess the presence or absence of contamination in the groundwater, surface water, and soils at the sites. A stepped approach is outlined in the IAG and will be used in Phase I to achieve this objective. This approach uses an iterative process involving continuing reassessment of the site conditions as data are obtained. Based on this process, the subsequent field sampling program may be modified to collect more representative data for each IHSS. This FSP describes this stepped process.

Based on the previous investigations and historical data presented in Section 2.0 of this report, the primary potential contaminants of concern are metals and radioactive materials. Insufficient data exists to confirm or deny the presence of organic compounds in IHSSs within OU5.

7.1.2 Sampling Rationale

As discussed above, a stepped approach will be used for the sampling program. There are four steps which may be completed at any site.

- Step 1 consists of a review of existing data, including aerial photographs and site records. Data from ongoing or other operable unit investigations that have become available since preparation of this Phase I work plan will be compiled and evaluated. These data will be validated as appropriate for incorporation into the OU5 site characterization. This review of existing information has already been partially performed during preparation of this Phase I work plan.

- Step 2 involves screening activities, including radiation surveys, magnetometer surveys, and a soil gas survey at the Original Landfill area. These activities are designed to provide Phase I screening-level data concerning the presence or absence of contaminants at the sites.

- Step 3 consists of Phase I sampling activities for soil, sediment, and surface water. Soil borings will be completed at some IHSSs to collect samples at depth and to characterize the IHSS. Some of the sampling locations may be selected to investigate anomalies identified in the Step 2 soil gas and radiation surveys. This step will provide confirmation of the Phase I screening data as well as aid in Phase I geologic and hydrogeologic characterization of the sites.

- Step 4 is monitoring well installation and sampling, which will follow Step 3 Phase I characterization and sampling. Groundwater monitoring wells will be installed to characterize the hydrogeologic setting of each site and to monitor alluvial groundwater conditions within or downgradient of several sites. These wells will be sampled after completion and development, and the results will be included in the Phase I RFI/RI Report.

7.1.3 Modifications to the IAG Plan

Several sampling and analytical activities described in the Interagency Agreement (IAG) have been modified in this FSP. These modifications, listed below, have been made so that each IHSS can be better evaluated during the Phase I investigation. Modifications to the Phase I sampling program are presented first followed by modifications to the Phase I analytical program.

Phase I Sampling Program Modifications

1) Radiation surveys and limited soil sampling will be conducted at the Surface Disturbance areas. The purpose of these activities is to assess the presence or absence of contaminants at these sites. The rationale for this sampling is that if contamination is not found, the surface disturbances can be removed from further phases of the RFI/RI process.

2) An investigation of a second surface disturbance (south of the Ash Pits) has been added to the Phase I investigation. This is an area where unknown activities have taken place at excavation and fill areas. The investigation of this area will include a review of the aerial photos, a radiation survey, surface soil sampling, and nine soil borings. Details of this program are contained in subsection 7.2.4.

3) An investigation of a third surface disturbance west of IHSS 209 has been added to the Phase I investigation. The investigation of this area, which appears to have been a radio tower installation, will include a review of the aerial photos, a radiation survey, and surface soil sampling. Details of this program are contained in subsection 7.2.4.

4) No FIDLER radiation survey will be conducted at the Original Landfill (IHSS 115). This survey has been deleted from the Phase I investigation because a more comprehensive gamma radiation survey using a germanium detector was completed in the fall of 1990. In addition, a gamma radiation survey using a germanium detector will be used at the Ash Pits (IHSS 133) instead of the radiation surveys specified in the IAG.

5) Two-foot composite samples will not be used for volatile organics analysis at the Original Landfill (IHSS 115). Instead, discrete samples will be collected at two-foot increments for analysis. Composite samples are not appropriate for analysis of volatile organic compounds, since a significant portion of the volatiles present in a sample can be volatilized during compositing of a sample.

6) Five sediment samples are to be collected from both Ponds C-1 and C-2 (IHSSs 14GW.10 and 14GW.11), as proposed in the IAG. However, three of the five locations have been changed so that more representative samples of the pond sediment can be obtained. The five locations proposed in this Phase I FSP are:

    - In the deepest portion of the pond,

- In the pond, five feet from the inlet, and
- At three randomly selected locations within the pond.

The samples to be collected at the three random locations are the locations which have been changed from those specified in the IAG. These random samples will provide pond sediment data that can be statistically averaged, while the samples collected from the deepest part of the ponds are likely to provide worst case concentrations. These average and worst case concentrations can then be used to better characterize the extent and nature of any contamination in the ponds and provide more useful data for the Phase I baseline risk assessment. The three original sampling locations specified in the IAG would provide non-random data that cannot be used in statistical analyses.

7) Sediment samples from Woman Creek and the SID will be collected to characterize the drainage where existing data is currently lacking. These samples will be placed just downstream of the impact area (area where surface runoff from an IHSS reaches Woman Creek) for each IHSS along Woman Creek and along stream segments that need further characterization. Based on a review of the data collected at the existing 18 sediment sample locations, there exists a significant amount of information about the sediment in many parts of the OU5 drainages (see Section 2.0). The sampling locations specified in the IAG have been reduced where sample locations currently exist. Proposed sampling locations have been placed in areas that need further characterization. Based on this approach, two additional sampling locations have been placed downstream of the Ash Pits, four downstream of the Old Landfill, one between the Old Landfill and Pond C-1, one between Ponds C-1 and C-2, and four downgradient of Pond C-2. These proposed sampling locations in combination with the existing 18 sampling locations should be sufficient to characterize the Woman Creek and SID sediment.

8) Seven borings will be drilled and sampled in the Original Landfill (IHSS 115) area. One boring will be drilled at the location of each of the former ponds and six borings will be drilled in the disturbed area east of the landfill. The borings will be drilled 6 feet into weathered bedrock. Samples will be analyzed for the same constituents as other soil samples from the landfill. There have been no previous investigations in either the area of the former pond or the disturbance east of the landfill. These borings will provide Phase I data concerning the presence or absence of contamination at these locations.

9) One additional well will be installed downgradient of the Old Landfill (IHSS 115). The well will be located between existing wells 5786 and 7086 south of the SID. The well will be completed in the alluvial materials.

10) A magnetometer survey will be conducted over the Old Landfill (IHSS 115) and Ash Pits (IHSS 133). The survey will be used to evaluate the presence of metallic materials in the units.

Phase I Analytical Program Modifications

1) All the Phase I soil samples collected from the Ash Pits area (IHSSs 133.1-133.6) will be analyzed for metals as well as for uranium, gross alpha, and gross beta radiation. This should provide a more representative analysis of the wastes thought to be present in these pits. This is also appropriate, since the groundwater monitoring program calls for analysis of metals in wells downgradient of this IHSS. Details of this analytical program are summarized in subsection 7.3.2.

2) A gamma radiation scan will be conducted by EG&G or its contractor on each of the sediment samples collected from the location at the deepest portion of Ponds C-1 and C-2 (IHSSs 14GW.10 and 14GW.11). Sediment samples at these locations will be collected from the sediment core at five-centimeter intervals. The rationale behind including this analysis is to evaluate whether contamination may exist in thinly stratified layers and to provide additional data to characterize pond sediment.

3) The IAG specifies that water and sediment samples be analyzed for soluble and insoluble radionuclides and metals. For the purposes of this Phase I investigation, each of the water samples will be filtered, and both the filtered and unfiltered aliquots analyzed for the specified metals and radionuclides. The filtered sample will provide data on the dissolved constituents and the unfiltered sample will provide data on the total constituent concentrations. Also, water (both filtered and unfiltered) and sediments will be analyzed for both plutonium isotopes (239/240). This is consistent with the existing Rocky Flats analytical methods.

4) Several analyses have been added to the Phase I analytical program to address chemicals of interest in the Environmental Evaluation. Groundwater samples from wells installed at the Original Landfill (IHSS 115) and some of the sediment samples collected in Woman Creek will be analyzed for TCL pesticides/PCBs. All surface (0-2 inches) soil samples taken in OU5 and sediment samples collected in Woman Creek will be analyzed for total organic carbon (TOC).

5) The two sediment samples downgradient of the Ash Pits will not be analyzed for TCL volatiles and semi-volatiles. These organic compounds were not reported to be disposed of at these IHSSs and organics have not been detected in the data collected from existing sediment locations in and adjacent to Woman Creek near the Ash Pits. Radionuclides and TAL metals are the suspected contaminants at the Ash Pits and the sediment analytical program downgradient of these areas will focus on these analytes.

7.2 PHASE I INVESTIGATION PROGRAM

This section describes the Phase I investigation program for the IHSSs within OU5. For each IHSS, the tasks listed are generally divided into office activities prior to field sampling (Step 1), field screening activities prior to sampling (Step 2), field sampling activities (Step 3), and groundwater monitoring well installation and sampling (Step 4). As part of the field sampling program, data from site-wide monitoring programs and investigations at other OUs will be used as appropriate to add to, or substitute for, the data collected during the Phase I investigation. The sites included within OU5 are IHSS 115 - Original Landfill; IHSS 133 - Ash Pits 1-4, the Incinerator, and the Concrete Wash Pad; IHSS 14GW.10 and 14GW.11 - C-Series Detention Ponds; and IHSS 209 - Surface Disturbance Southeast of Building 881. Two additional surface disturbance will also be evaluated during this investigation. These are the surface disturbance west of IHSS 209 and the surface disturbances south of the Ash Pits. For reference, the Phase I investigation programs for each IHSS are summarized below. A number of standard operating procedures (SOPs) will be used during the investigation. The SOPs are cited in this section and discussed further in Section 11.0 of this Phase I work plan.

7.2.1 IHSS 115 - Original Landfill

Step 1 - Review Aerial Photographs

Aerial photographs taken during operation of the Original Landfill will be reviewed to identify the extent of the Original Landfill and the disturbed area located to the east of the Original Landfill. The areas to be studied during later steps of this investigation, including the location of former ponds, will be delineated from the aerial photographs and surveyed in on the ground as needed to define their locations for the Phase I field work. Additional studies conducted at the Landfill after preparation of this Phase I work plan will be evaluated during Step 1 (see Table 7-1). Also as part of Step 1, the gamma radiation survey conducted at the Original Landfill using a germanium detector (Appendix B) may be further reviewed as needed.

Step 2 - Soil Gas and Magnetometer Surveys

A real-time soil gas survey will be conducted over the Original Landfill and the disturbed area located to the east of the Landfill (Figure 7-1). As specified in the IAG, the soil gas samples will be taken on a 100-foot grid according to the procedures described in SOP GT.9. It is anticipated that a method utilizing a hand-driven probe may be necessary on the steep slopes of the Landfill. The probe will be driven approximately 2 feet into the soil to collect the soil gas. The soil gas samples will be analyzed for 1,1,1-trichloroethane (TCA), dichloromethane, benzene, carbon tetrachloride, tetrachloroethene (PCE), and trichloroethene (TCE). Analytical peaks of compounds for which the gas chromatograph

TABLE 7-1
PHASE I INVESTIGATION
IHSS 115 - ORIGINAL LANDFILL

Activity	Purpose	Location	Sample Number
Review Aerial Photographs	Identify extent and area east of Landfill	Entire site and eastward	NA
Review Radiation Survey	Identify areas of anomalous radiation readings		NA
Magnetometer Survey	Locate metallic objects	Entire site and eastward - 20 ft. grid	2, 490
Soil Gas Survey	Locate plumes of volatile organics	Entire site and eastward - 100 ft. grid	69
Soil Cores	Verify presence or non-presence of volatiles identified during soil gas survey	Random basis, 1 sample every 15 to 20 soil gas samples, at the depth of the soil gas probe	4
Soil Borings	Characterize subsurface conditions and contamination	One in each area of the former ponds, six in the disturbance east of the Landfill. Borings will be drilled at least 3 feet into weathered bedrock.	8
Soil Borings (if plumes are identified)	Transect plumes identified by soil gas survey, if identified	Three borings transecting three highest soil gas locations. Borings will be placed at point of highest reading and two locations downslope of the point. Borings will be drilled at least 6 ft. into weathered bedrock.	Maximum of 9
Complete wells in borings (if plumes are identified)	Monitor alluvial groundwater in plume, if identified	In borings at the points of highest readings	Maximum of 3
Install wells	Monitor alluvial groundwater downgradient of the unit	See Figure 7-1	4
Review plant plans, conduct sewer snake survey	Confirm interconnections of two pipes daylighting in the Landfill	Two pipes in Landfill	NA
Sample effluent (if present)	Characterize effluent from the pipes	Pipe outfalls	2
Sample sediment and surface water	Characterize sediment and surface water downgradient of the unit	Two and three locations along SID and Woman Creek for sediment and surface water, respectively	4 sediment and 6 surface water

NA - Not Applicable

(GC) is not calibrated will be noted. The soil gas survey will be conducted using a portable GC. The analytical program for the soil gas survey is discussed in subsection 7.3.2.

A magnetometer survey will be performed over the Old Landfill and the disturbed area to the east. This survey will be conducted on a 20-foot grid in the area outlined for the radiation survey in Figure 7-2. The survey will be completed according to the magnetic locator procedure in SOP GT.10. Resulting anomalies will be mapped and contoured.

Step 3 - Soil Cores, Soil Borings, Surface Water, and Sediment Samples

Soil cores will be collected on a random basis to verify the soil gas survey. One soil core (grab sample) will be collected for every 15 to 20 soil gas samples at the same depth as the soil gas samples. Based on the number of soil gas sampling locations, it is estimated that four soil cores will be collected. One soil boring will be drilled in the location of each of the two former ponds. Six soil borings will be drilled in the disturbed area east of the landfill. If plumes are identified by the soil gas survey, soil borings will be utilized to transect the plumes and aid in their characterization. Three borings will be placed at up to three areas where plumes have been identified by the soil gas. This will result in a maximum of nine soil borings being drilled at the three plume areas. At each plume area, one soil boring will be placed at the point of the highest soil gas reading, and two borings will be located downslope of that point within the plume identified by the soil gas survey. Each soil boring will be drilled at least 6 feet below the base of the alluvial material according to the procedures described in SOP GT.2. Samples will be taken continuously in these borings. Discrete samples will be collected from every 2-foot increment and analyzed for the Target Compound List (TCL) for volatile organic compounds. Samples will be composited from every 6-foot interval and analyzed for the TCL for semivolatile organic compounds, the Total Analyte List (TAL) for metals and radionuclides. As specified in the SOP, samples will not be collected for chemical analysis from the saturated alluvium. The analytical program for those samples is presented in subsection 7.3.

During sampling a soil classification survey will be completed at the Original Landfill for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

The two corrugated metal pipes protruding from the Landfill (Figure 7-1) will also be investigated in this FSP. Plant plans will be reviewed and a sewer snake survey will be conducted to attempt to identify the open length of the pipes and the sources of water. This survey may use a traceable electronic or magnetic source attached to the snake such that surface instruments can be used to follow the path of the pipe. Other methods for locating pipes may also be used if the sewer snake survey is inconclusive. If water is found to be flowing through either of the corrugated pipes during this Phase

I investigation, the effluent will be sampled according to SOP SW.3. Results of the sampling will be reported in the Phase I RI Report.

The sediments and surface water of the South Interceptor Ditch (SID) and Woman Creek will be sampled immediately downgradient of the Original Landfill. These locations are shown in Figure 7-2, which is a map of all the proposed surface water and sediment sampling locations for OU5. Surface water samples will be collected at three locations along the SID and three locations on Woman Creek (total of six samples) according to the procedures specified in SOPs SW.2 and SW.3 for surface water. Sediment samples will be collected at two locations along the SID and two locations on Woman Creek (total of four samples) according to procedures specified in SOP SW.6 (see Section 7.2.3). The sediment samples will be collected in areas of the creek or ditch that are conducive to sediment accumulation. The analyses to be performed on these samples are listed in subsection 7.3.

During sampling a soil classification survey will be completed at the Old Landfill for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

Step 4 - Monitoring Wells

If soil borings are used to transect soil gas plumes, monitoring wells will be installed in the borings with the highest soil gas readings. A maximum of three monitoring wells will be installed in these borings. As specified in the IAG, all of these wells will be installed in the alluvium just above the bedrock according to SOP GT.6.

In addition to the above wells, four monitoring wells will be installed in the alluvial aquifer downgradient of the Original Landfill. Three wells will be installed between the Landfill and the SID and one well will be installed between the SID and Woman Creek (Figure 7-1). The first-well will be placed between the western leg of the Landfill and the SID. The second well will be placed in the alluvium in the surface drainage north of Well 5786 between the Landfill and the SID within the area of the old embankment. The third well will be placed in the alluvium between the southeastern corner of the boundary of IHSS 115 and the SID, downgradient of the outfall identified on the east side of the Landfill. The fourth well will be placed between existing wells 5786 and 7086. If a water-bearing sandstone unit is found to be the first bedrock unit underlying the alluvium in a boring, then the well will be completed in the sandstone at that location. These wells should monitor the principal groundwater migration pathway downgradient of the Original Landfill.

The four proposed groundwater monitoring wells will be drilled according to SOP GT.2 and installed according to SOP GT.6. All wells will be developed according to SOP GW.2. Following development, wells will be sampled according to SOPs GW.5 and GW.6. The analyses to be performed on these samples are listed in subsection 7.3. The results of the first round of sampling will be reported in the Phase I RI Report. The four monitoring wells downgradient of the Landfill will be sampled quarterly for a minimum one year.

7.2.2 IHSS 133 - Ash Pits 1-4, Incinerator, and Concrete Wash Pad

Step 1 - Review Aerial Photographs

Aerial photographs from 1953, 1955, 1964, 1969, and 1978 through 1988 will be reviewed to identify the extent of the disposal areas for these sites including an area north of the west access road and possible waste disposal areas beyond the boundaries of Ash Pit 1 and the Concrete Wash Pad (see Section 2.0). The dimensions of each pit, determined from the aerial photographs, will be used to assist in planning the Phase I drilling program and for defining the area of the radiation survey (see Table 7-2).

Step 2 - Radiation and Magnetometer Survey

A ground based radiation survey employing a high purity germanium gamma-ray sensor will be performed over the four Ash Pits, the Concrete Wash Pad, and the Incinerator. The area to be surveyed for IHSS 133 is shown on Figure 7-2 and extends from the western boundary of the previously surveyed area over the Original Landfill (Appendix B) to approximately 600 feet west of the Concrete Wash Pad. The sodium iodide sensors employed for this survey will be spaced such that there is overlapping coverage between stations so that essentially 100% coverage can be obtained. The gamma emitting radionuclides that are detected will be analyzed to identify the isotopes that may be present. Prior to implementation, an SOP will be developed for performing this survey. If areas of anomalous radiation readings are detected, they will be surveyed sufficiently to define their lateral extent. The results will be plotted and contoured on a map and will also be presented in tabular form.

A magnetometer survey will be performed over the Ash Pits in the same area as outlined for the radiation survey on Figure 7-2. This survey will be conducted on a 20-foot grid according to the magnetic locator procedure described in SOP GT.10. Resulting anomalies will be mapped and contoured.

Step 3 - Surface Soil Sampling and Soil Borings

Surface soil samples will be collected to a depth of 2 inches at the central location of all areas identified by the radiation survey as having above-background radiation levels. These soil samples will be collected according to the sampling procedures specified in SOP GT.8.

TABLE 7-2

PHASE I INVESTIGATION
IHSS 133 - ASH PITS 1-4, INCINERATOR, AND CONCRETE WASH PAD

Activity	Purpose	Location	Sample Number
Review Aerial Photographs	Identify extent of the areas, including areas beyond the boundaries of the units	Entire site and north of road	NA
Radiation Survey	Locate areas of anomalous radiation readings	IHSS areas, areas between pits, and area between Ash Pits and Landfill	NA
Magnetometer Survey	Locate metallic objects	Same as radiation survey	4, 864
Surface Soil Sampling	Characterize radiation hotspots	Central location of areas of radiation above background	Unknown
Soil borings	Characterize subsurface conditions and contamination	On 25-foot centers and over hotspots. Borings will be drilled 5 ft. into weathered bedrock.	85
Install wells	Monitor alluvial groundwater downgradient of the unit	See Figure 7-3	3

NA - Not Applicable

Borings will be drilled during the Phase I investigation to collect samples for analysis and to further characterize the pits and pads. As specified in the IAG, these borings will be placed on 25-foot centers along the long axis of each pit or pad, as identified in Step 1 (see Figure 7-3). Borings will also be placed along the short axis of each pit to aid characterization efforts. Soil borings will also be placed over areas of anomalous radiation readings detected during the radiation survey. Based on the present size of the Ash Pits, Incinerator, and Wash Pad, it is estimated that approximately 85 borings on 25-foot centers will be drilled in the area. Each boring will be drilled 5 feet into weathered bedrock and will be drilled and sampled according to procedures contained in SOP GT.2. Samples will be taken continuously in these borings. Samples will be composited from every 2-foot interval and analyzed for metals, total uranium, gross alpha, and gross beta (see subsection 7.3).

During sampling a soil classification survey will be completed at the Ash Pits for use in the Environmental Evaluation. Several samples may also be collected form 0 to 2 feet for grain size analysis.

Step 4 - Monitoring Wells

Three monitoring wells will be installed downgradient of the Ash Pits between IHSS 133 and Woman Creek (preliminary locations are shown on Figure 7-3). Locations for the wells will be selected following the Step 3 activities and after a review of the geologic characteristics of the site. The locations will be proposed to the Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH) prior to well installation. The wells will be drilled according to SOP GT.2, installed according to SOP GT.6, and developed according to SOP GW.2. The wells will be screened to monitor the saturated section of the alluvium. If a water-bearing sandstone unit is found to be the first bedrock unit underlying the alluvium in a boring, then the well will be completed in the sandstone unit at that location. Following development, the wells will be sampled according to SOP GW.5 and GW.6. The Phase I analytical program for samples collected from these wells is contained in subsection 7.3. The results of the first round of sampling will be reported in the Phase I RI Report. The wells will be sampled quarterly for a minimum of one year.

7.2.3 IHSS - 142.10-11 - C-Series Detention Ponds

Step 1 - Review of Existing Data

Surface water and sediment samples are currently being collected at locations in the Woman Creek drainage as part of ongoing monitoring activities at the Rocky Flats Plant. The sampling locations, methodology, analytical parameters, and results from this monitoring will be reviewed prior to the Phase I field investigation to assess the potential overlap between the programs. Data collected during the ongoing monitoring may satisfy the requirements of this OU5 program and will be utilized, if appropriate

(Table 7-3). Also, as specified in the IAG, the 1986 report "Trends in the Rocky Flats Surface Water Monitoring" (U.S. DOE 1986a) and other data pertaining to these ponds will be submitted to the EPA and the CDH.

Step 2 - Surface Water and Sediment Samples

Five surface water samples will be collected from each of the two C-Series Detention Ponds. At least one of the five water samples at each pond will be taken from the deepest part of the pond. As specified in the IAG, during the collection of this sample, the presence of stratification in the pond water will be evaluated. Stratification of the water column will be identified through temperature and/or dissolved oxygen measurements taken according to SOP SW.8. If stratification of the pond is identified at this location, grab water samples will be taken from each vertically stratified zone. The second surface water sample from each pond will be collected within 5 feet of the inlet to the pond. The third surface water sample for each pond will be collected within 5 feet of the pond spillway. The two remaining sampling locations will be selected at random based on the size of the pond at the time of sample collection. The surface water sample collected at each location will consist of a composite sample from the entire vertical water column, except for the grab samples at the deepest sampling location (described above). Samples will be collected according to SOPs SW.1, SW.2, and SW.8 as they apply to pond water sampling.

Five sediment samples will be collected from each of the two C-Series Detention Ponds (Figure 7-4). One of the five sediment samples will be taken within the pond 5 feet from the inlet. A second sediment sample will be collected from the deepest part of each pond. The other three samples will be taken from random locations within the pond as it exists at the time of sampling. All sediment samples will represent the entire vertical column of sediment present at each location. If the sediment depth is greater than 2 feet, 2-foot composite samples will be collected. Sediment samples will be geologically logged according to SOP GT.1.

In addition to the above samples, grab sediment samples will be collected from discrete vertical intervals in the sediment core taken from the deepest part of the pond. These sediment samples will consist of composite samples collected at 2-inch intervals in this core. Each of these samples will be analyzed by a gamma radiation scan.

Sediment samples will also be collected along Woman Creek from the Concrete Wash Pad (IHSS 133.6) to Indiana Street and along the SID (Figure 7-2). There already exists data on the sediments in the OU5 area (see Section 2.0). The pre-existing data were used to focus the Phase I sediment data collection efforts in areas where there are data gaps. In developing the OU5 sediment sampling program, the areas where each IHSS would impact this drainage have been estimated so that the additional field sampling locations can be positioned downstream of these impact areas (Figure 7-5). These impact

TABLE 7-3

PHASE I INVESTIGATION
IHSS 142.10-11 - C-SERIES DETENTION PONDS

Activity	Purpose	Location	Sample Number
Collect surface water samples	Characterize surface water contamination	5 locations in each pond and from each vertically stratified zone at the deepest point in the pond	16
Collect sediment samples in ponds	Characterize sediments in ponds and contamination	5 locations in each pond. Samples will also be taken from each 5 centimeter interval of sediment from the deepest part of each pond.	10
Collect sediment samples in other locations on Woman Creek	Characterize Woman Creek sediments and contamination	See Figure 7-2 and text	10
Collect sediment samples in the South Interceptor Ditch	Characterize South Interceptor Ditch sediments and contamination	See Figure 7-2 and text	2
Install wells	Monitor alluvial groundwater downgradient of the ponds	Below ponds C-1 and C-2 dams (2 each)	4

areas have been estimated by defining the area where surface water runoff from each IHSS intercept the drainage.

Based on these impact areas, additional field sampling locations have been positioned downgradient of each IHSS where there was a lack of existing data (Figure 7-5). Table 7-4 lists these additional sediment sampling locations proposed for OU5 and their purposes, along with what existing sediment locations will be used to characterize each area. The sediment samples collected from each pond are not included on Table 7-4. Generally, additional sampling locations are placed downstream of each IHSS and along each stream segment where existing data is lacking to characterize the stream sediment (Table 7-4 and Figure 7-5). Data from these additional sampling locations along with the sediment data that has already been collected will be used to evaluate Woman Creek and the SID in OU5 for the Phase I RI Investigation.

The sediment samples from Woman Creek and the SID will be collected within the creek or ditch at points that are conducive to the collection of sediment. The sample at each location will consist of 2-foot composite samples taken to the depth of the first gravel layer below the sediment. If the sediment is thicker than two feet then additional two-foot composite samples will be collected.

All sediment samples will be collected according to SOP SW.6 and the SOP Addendum (SOPA) to SOP SW.6 in Section 11.0 of this document. The chemical analyses that will be performed on these samples is presented in subsection 7.3.

Step 3 - Monitoring Wells

Two monitoring wells will be installed immediately downgradient of each dam at Detention Ponds C-1 and C-2, thus providing a total of four monitoring wells in this area (Figure 7-4). The wells will be constructed within the original stream channel according to SOP GT.6 and will monitor the saturated alluvium. If a water-bearing sandstone unit is found to be the first bedrock unit underlying the alluvium in a boring, then the well will be completed in the sandstone at that location. Following development of the wells according to SOP GW.2, the wells will be sampled according to SOPs GW.5 and GW.6. Results of the first round of well sampling will be reported in the Phase I RI Report. These wells will be sampled quarterly for one year. The chemical analyses that will be performed on these samples are discussed in subsection 7.3.

7.2.4 IHSS 209 - Surface Disturbance Southeast of Building 881 and Other Surface Disturbances

There are three surface disturbances that will be evaluated during the Phase I investigation: IHSS 209, the surface disturbance west of IHSS 209, and the surface disturbances south of the Ash Pits (Figures

TABLE 7-4

PROPOSED SEDIMENT SAMPLING PROGRAM[1]

IHSS or Stream Segment	Proposed Locations	Existing Locations	Purpose
Ash Pits, Concrete Wash Pad, and Incinerator (Woman Creek)	2	SED-14 and SED-17	Characterize Woman Creek sediment downstream of IHSS 133.
Original landfill (Woman Creek and SID)	4	0	Characterize sediments downstream of landfill in both SID and Woman Creek
Between IHSS 115 and Pond C-1	1	SED-126	Characterize sediments in SID and Woman Creek
SID Between Pond C-1 and C-2	0	SED-28, SED-31, SED-29, and SED-30	Characterize SID
Woman Creek between C-1 and C-2	1	SED-27, SED-26, and SED-25	Characterize Woman Creek between ponds
Woman Creek between C-2 and Indiana Street	4	SED-1, SED-2, and SED-24	Characterize Woman Creek and Unnamed Ditch

[1] The 5 sediment samples for each pond are not included in this table.

7-3 and 7-4). The Phase I field sampling programs for these areas are similar and are described below. Table 7-5 summarizes the proposed program for these areas.

Step 1 - Review Aerial Photographs

Available aerial photographs, including those from 1964, 1969, 1971, and 1983, will be reviewed to evaluate the nature and use of IHSS 209, the surface disturbance west of IHSS 209, and the surface disturbance south of the Ash Pits (see Table 7-5). These photos will help to determine if there are any specific areas within each of these surface disturbances that should be investigated more fully. In addition, the features that appears to be a pond at IHSS 209 in a 1983 and 1988 aerial photo will be evaluated.

Step 2 - Visual Inspection and Radiation Survey

A visual inspection will be conducted over the three surface disturbances to identify any stained soil and anomalous surface areas. A FIDLER radiation survey will also be performed at the areas according to SOP FO.16. This survey will be conducted randomly over each surface disturbance. If areas of anomalous radiation readings are detected, the survey will be adjusted to pinpoint the radiation source. The results of the surveys will be plotted on a map and contoured, if appropriate. The radiation surveys will be conducted using a side-shielded FIDLER and a shielded G-M pancake-type detector. If appropriate, the Step 3 field sampling program will be adjusted to investigate anomalies identified from the Step 2 visual inspection and radiation survey.

Step 3 - Soil, Surface Water, and Sediment Samples

A sediment sample and surface water sample (if present) will be collected from the deepest part of both pond-like depressions at IHSS 209 according to SOPs SW.1, SW.2, SW.3, and SW.6 (Figure 7-4). Also, a grab sample of soil will be collected from the surface to a depth of 6 inches in the center of each of the three small excavations at IHSS 209 according to SOP GT.8.

At the surface disturbance west of IHSS 209, one composite grab sample of soil will be collected from the surface to a depth of 6 inches in the center of each of the five small disturbed areas according to SOP GT.8. These five samples will be composited and one sample will be sent to the lab for analysis.

At the surface disturbance south of the Ash Pits, two soil borings will be drilled in each of the parallel excavations, one in the east excavation area, and four in the west excavation area, resulting in a total of nine borings (Figure 7-3). The borings will be drilled to a depth of 12 feet and will be drilled and sampled according to SOP GT.2. The borings will be logged according to SOP GT.1. Samples will be taken continuously. Discrete samples will be collected from every 2-foot increment and analyzed for

TABLE 7-5

PHASE I INVESTIGATION
IHSS 209 - SURFACE DISTURBANCE SOUTHEAST OF BUILDING 881, THE SURFACE DISTURBANCE WEST OF IHSS 209 AND THE SURFACE DISTURBANCES SOUTH OF THE ASH PITS

Activity	Purpose	Location	Sample Number
Review Aerial Photographs	Evaluate nature and use of sites and nature of the ponds at IHSS 209	IHSS 209, surface disturbance west of IHSS 209 and surface disturbances south of the Ash Pits	NA
Visual Inspection	Identify stained soil areas	IHSS 209, surface disturbance west of IHSS 209 and surface disturbances south of the Ash Pits	NA
Radiation Survey	Locate areas of anomalous radiation readings	Random survey over area	NA
Sample Sediment and Surface Water	Characterize the two ponds on IHSS 209	From the center of the ponds at IHSS 209	2 each sediment and surface water
Soil Borings	Evaluate surface disturbances south of Ash Pits	2 in each of the parallel excavations, 4 in west fill area, and 1 in east fill area	9
Sample soil	Evaluate potential contamination in small depressions in IHSS 209	One sample from each of the small depressions	3
Surface Sample	Evaluate potential contamination in surface disturbance south of Ash Pits	One in north-south excavation, and at stained areas and radiation hotspots	1 and unknown
Surface Sample	Evaluate potential contamination at each of the five small disturbed areas in the surface disturbance west of IHSS 209.	One composite surface grab sample from the five disturbed areas.	1

NA - Not Applicable

the TCL for volatile organic compounds. Samples will be composited from every 6-foot interval and analyzed for the TCL for semivolatile organic compounds, the TAL for metals and radionuclides. One surface soil sample will be collected in the north-south excavation (Figure 7-3).

In addition, surface soil samples will be collected at any areas of anomalous radiation readings or stained areas identified from the visual inspection and radiation surveys of these disturbed areas. The analytical program for these soil and water samples is presented in the following section.

During sampling a soil classification survey will be completed at the Surface Disturbances for use in the Environmental Evaluation. Several samples may also be collected from 0 to 2 feet for grain size analysis.

7.2.5 Ambient Air Monitoring Program

Three Hi-Vol air sampling devices will be installed near the Woman Creek drainage to monitor the air pathway from this Operable Unit (Figure 7-2). One will be located northwest of the Ash Pits (IHSS 133) and the Old Landfill (IHSS 115) to provide background data. The second air monitoring station will be placed between the Ash Pits and the Old Landfill, with the third southeast of the Old Landfill.

The data obtained from these stations, as well as the existing nearby air stations, will be used to evaluate the air emissions from this area. There are currently seven air monitoring stations (S-10, S-11, S-13, S-14, S-23, S-37, and S-38) near the Woman Creek drainage (Figure 7-2). The three proposed monitoring stations will be sampled in accordance with the Site-Wide Ambient Air Monitoring Program currently being conducted by EG&G at the Rocky Flats Plant. Briefly, the operation and sampling procedures are described below.

Air coming in contact with the Hi-Vol Ambient Air samples is forced through a filter material, trapping radioactive particulates and other airborne matter for subsequent analysis. Performance data from these RAAMP air samplers are collected by Environmental Monitoring and Assessment Technologists (EMAT) on a weekly basis, and air filters are replaced every 2 weeks. Once a month, the two filters collected from each air monitoring station are composited, and one sample from each air monitoring station is sent to Radiological Health Labs (Building 123) at the Plant for analysis. Detailed procedures describing the air sampler operations, filter exchange, filter preparation for analysis, RAAMP documentation, and reporting requirements are contained in SOP AP.13. These air samples will be analyzed according to the procedures outlined in the GRRASP. The samples will be analyzed for the same analytes as are analyzed in the site-wide program (which is currently plutonium). The analytical program for the site-wide Ambient Air Program is expected to be expanded in the near future to include other radionuclides, at which time the analytical program for the three proposed OU5 air stations will also be increased.

7.3 SAMPLE ANALYSIS

This section describes the sample handling procedures and analytical program for samples collected from the Phase I investigation. In this section, sample designations, analytical requirements, sample containers and preservation, and sample handling and documentation requirements will be discussed.

7.3.1 Sample Designations

All sample designations generated for this RFI/RI will conform to the input requirements of the Rocky Flats Environmental Database System (RFEDS). Each sample designation will contain a nine-character sample number consisting of a two-letter prefix identifying the media sampled (e.g., "SB" for soil borings, "SS" for stream sediments), a unique five-digit number, and a two-letter suffix identifying the contractor (e.g., "WC" for Woodward-Clyde). One sample number will be required for each sample generated, including Quality Assurance (QA)/Quality Control (QC) samples. In this manner, 99,999 unique sample numbers are available for each contractor that contributes sample data to the database. A block of numbers will be reserved for the Phase I RFI/RI sampling of OU5. Boring numbers will be developed independently of the sample numbers from a boring. Specific sample location numbers are not assigned at this time, pending the results of the aerial photograph analysis and review of existing data.

7.3.2 Analytical Requirements

Generally, samples collected during the Phase I RI will be analyzed for some or all of the following chemical and radionuclide parameters:

- Nitrate
- TAL metals
- Uranium 233/234, 235, and 238
- Transuranic elements (plutonium and americium)
- Cesium 137 and strontium 89/90
- Gross alpha and gross beta
- Tritium
- Total dissolved chromium (water only)
- Beryllium
- TCL volatile organics
- TCL semivolatile organics
- Total organic carbon (TOC)
- TCL pesticides/PCBs
- CO_3, HCO_3, Cl, SO_4, NO_3 (water only)

The specific analytes in the groups listed above and their detection/quantitation limits are contained in Table 7-6. Table 3-1 lists the analytical methods that will be used for each analyte. The specific Phase I analytical programs for each IHSS are contained in Table 7-7. Both filtered and unfiltered surface water and groundwater samples will be analyzed at each location.

The analytical program for each media at every IHSS is summarized in Table 7-7. The analytical program for each IHSS was developed in the IAG based on the type of waste suspected to be present at each site. The specific analytes and detection/quantitation limits are specified in the IAG by reference to CLP (Contract Laboratory Program) analyses. The General Radiochemistry and Routine Analytical Services Protocol (GRRASP) (EG&G 1990f) provides a listing of CLP analytes and limits that will be used for this Phase I RFI/RI. These analytes and limits are presented in Table 7-6. The program shown in Table 7-7 should address the bulk of chemicals and compounds that were handled or are suspected to be present at OU5 and enable detection of soil, sediment, surface water, and groundwater contamination, if present.

Nitrates are included because low-level radioactive wastes with high nitrate concentrations may be present in Woman Creek or the SID. Metals were probably disposed of at OU5; however, details are not well known. Therefore, all of the TAL metals have been selected for Phase I analysis.

Uranium is likely to have been a constituent of the wastes at OU5. The isotopes U-233, U-234, U-235, and U-238 have been selected for analysis in Phase I. Plutonium is the only transuranic element that is used on the site. However, americium is a daughter product of plutonium and is found at the Rocky Flats Plant. Therefore, plutonium and americium have also been selected as Phase I radionuclide parameters. Gross alpha and gross beta are included as screening parameters because they are useful indicators of radionuclides. Tritium, strontium, and cesium are also included in the analytical program.

Volatile and semivolatile organics may have been handled at OU5 in small quantities probably only at the Original Landfill. The specific compounds used are unknown; therefore, all of the TCL volatile and semivolatile organics will be included in the Phase I analyses for some samples.

TCL pesticides/PCBs and TOC have been included for some samples to provide data for the environmental evaluation. For the sediment samples collected from Woman Creek and the SID, TCL pesticides will be analyzed in the samples collected from the detention ponds and at the location just downgradient from the Original Landfill. The other sediment samples collected from Woman Creek and the SID will not be analyzed for TCL pesticides as no pesticides have been detected to date from the extensive sampling already performed (see Section 2.0). In addition, the two proposed sediment sampling locations just downstream of the Ash Pit will not be analyzed for TCL volatiles and semi-volatiles since incineration would probably have destroyed these organics.

TABLE 7-6

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS AND DETECTION LIMITS

	DETECTION LIMITS*	
TARGET ANALYTE LIST - METALS	Water (μg/l)	Soil/Sediment (mg/kg)
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1.0
Cadmium	5	1.0
Calcium	5000	2000
Cesium	1000	200
Chromium	10	2.0
Cobalt	50	10
Copper	25	5.0
Cyanide	10	10
Iron	100	20
Lead	5	1.0
Lithium	100	20
Magnesium	5000	2000
Manganese	15	3.0
Mercury	0.2	0.2
Molybdenum	200	40
Nickel	40	8.0
Potassium	5000	2000
Selenium	5	1.0
Silver	10	2.0
Sodium	5000	2000
Strontium	200	40
Thallium	10	2.0
Tin	200	40
Vanadium	50	10.0
Zinc	20	4.0
TOTAL ORGANIC CARBON	1	1
	QUANTITATION LIMITS*	
TARGET COMPOUNDS LIST - VOLATILES	Water (μg/l)	Soil/Sediment (μg/kg)
Chloromethane	10	10
Bromomethane	10	10
Vinyl Chloride	10	10
Chloroethane	10	10
Methylene Chloride	5	5
Acetone	10	10
Carbon Disulfide	5	5
1,1-Dichloroethene	5	5
1,1-Dichloroethane	5	5

TABLE 7-6
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS AND DETECTION LIMITS

	QUANTITATION LIMITS*	
TARGET COMPOUNDS LIST - VOLATILES (Continued)	Water (μg/l)	Soil/Sediment (μg/kg)
total 1,2-Dichloroethene	5	5
Chloroform	5	5
1,2-Dichloroethane	5	5
2-Butanone	10	10
1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Vinyl Acetate	10	10
Bromodichloromethane	5	5
1,1,2,2-Tetrachloroethane	5	5
1,2-Dichloropropane	5	5
trans-1,3-Dichloropropene	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5
cis-1,3-Dichloropropene	5	5
Bromoform	5	5
2-Hexanone	10	10
4-Methyl-2-pentanone	10	10
Tetrachloroethene	5	5
Toluene	5	5
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Total Xylenes		

	QUANTITATION LIMITS*	
TARGET COMPOUNDS LIST - SEMIVOLATILES	Water (μg/l)	Soil/Sediment (μg/kg)
Phenol	10	330
bis(2-Chloroethyl)ether	10	330
2-Chlorophenol	10	330
1,3-Dichlorobenzene	10	330
1,4-Dichlorobenzene	10	330
Benzyl Alcohol	10	330
1,2-Dichlorobenzene	10	330
2-Methylphenol	10	330
bis(2-Chloroisopropyl)ether	10	330
4-Methylphenol	10	330
N-Nitroso-di-n-dipropylamine	10	330
Hexachloroethane	10	330

TABLE 7-6
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS
AND DETECTION LIMITS

TARGET COMPOUND LIST - SEMIVOLATILES (Continued)	QUANTITATION LIMITS* Water (μg/l)	Soil/Sediment (μg/kg)
Nitrobenzene	10	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
Benzoic Acid	50	1600
bis(2-Chloroethoxy)methane	10	330
2,4-Dichlorophenol	10	330
1,2,4-Trichlorobenzene	10	330
Naphthalene	10	330
4-Chloroaniline	10	330
Hexachlorobutadiene	10	330
4-Chloro-3-methylphenol(para-chloro-meta-cresol)	10	330
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	50	1600
2-Chloronaphthalene	10	330
2-Nitroaniline	50	1600
Dimethylphthalate	10	330
Acenaphthylene	10	330
2,6-Dinitrotoluene	10	330
3-Nitroaniline	50	1600
Acenaphthene	10	330
2,4-Dinitrophenol	50	1600
4-Nitrophenol	50	1600
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
Diethylphthalate	10	330
4-Chlorophenyl Phenyl ether	10	330
Fluorene	10	330
4-Nitroaniline	50	1600
4,6-Dinitro-2-methylphenol	50	1600
N-nitrosodiphenylamine	10	330
4-Bromophenyl Phenylether	10	330
Hexachlorobenzene	10	330
Pentachlorophenol	50	1600
Phenanthrene	10	330
Anthracene	10	330
Di-n-butylphthalate	10	330
Fluoranthene	10	330
Pyrene	10	330
Butylbenzylphthalate	10	330

TABLE 7-6
(Continued)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS AND DETECTION LIMITS

TARGET COMPOUND LIST - SEMIVOLATILES (Continued)	Water (µg/l)	Soil/Sediment (µg/kg)
3,3'-Dichlorobenzidine	20	660
Benzo(a)anthracene	10	330
Chrysene	10	330
bis(2-Ethylhexyl)phthalate	10	330
Di-n-octylphthalate	10	330
Benzo(b)fluoranthene	10	330
Benzo(k)fluoranthene	10	330
Benzo(a)pyrene	10	330
Indeno(1,2,3-cd)pyrene	10	330
Dibenz(a,h)anthracene	10	330
Benzo(g,h,i)perylene	10	330
TARGET COMPOUND LIST - PESTICIDES/PCBS	QUANTITATION LIMITS*	
	Water µg/l	Soil/Sediment µg/kg
alpha-BHC	0.05	8.0
beta-BHC	0.05	8.0
delta-BHC	0.05	8.0
gamma-BHC (Lindane)	0.05	8.0
Heptachlor	0.05	8.0
Aldrin	0.05	8.0
Heptachlor epoxide	0.05	8.0
Endosulfan I	0.05	8.0
Dieldrin	0.10	16.0
4,4'-DDD	0.10	16.0
Endrin	0.10	16.0
Endosulfan II	0.10	16.0
4,4'-DDD	0.10	16.0
Endosulfan sulfate	0.10	16.0
4,4'-DDT	0.10	16.0
Methoxychlor	0.5	80.0
Endrin ketone	0.10	16.0
alpha-Chlordane	0.5	80.0
gamma-Chlordane	0.5	80.0
Toxaphene	1.0	160.0
Aroclor-1016	0.5	80.0
Aroclor-1221	0.5	80.0
Aroclor-1232	0.5	80.0
Aroclor-1242	0.5	80.0
Aroclor-1248	0.5	80.0
Aroclor-1254	1.0	160.0
Aroclor-1260	1.0	160.0

TABLE 7-6
(Concluded)

PHASE I
SOIL, SEDIMENT, AND WATER SAMPLING PARAMETERS AND DETECTION LIMITS

	REQUIRED DETECTION LIMITS*	
RADIONUCLIDES	Water (pCi/ℓ)	Soil/Sediment (pCi/g)
Gross Alpha	2	4 dry
Gross Beta	4	10 dry
Uranium 233+234, 235, and 238 (each species)	0.6	0.3 dry
Americium 241	0.01	0.02 dry
Plutonium 239+240	0.01	0.03 dry
Tritium	400	400 (pCi/ml)
Cesium 137	1	0.1 dry
Strontium 89+90	1	1 dry

	DETECTION LIMITS*
Parameters Exclusively for Groundwater Samples	Water (mg/ℓ)
ANIONS	
Carbonate	10
Bicarbonate	10
Chloride	5
Sulfate	5
Nitrate as N	5
FIELD PARAMETERS	
pH	0.1 pH unit
Specific Conductance	1
Temperature	
Dissolved Oxygen	0.5
Barometric Pressure	
INDICATORS	
Total Dissolved Solids	5

* Detection and quantitation limits are highly matrix dependent. The limits listed here are the minimum achievable under ideal conditions. Actual limits may be higher.

TABLE 7-7
PHASE I ANALYTICAL PROGRAM

IHSS	Location	Media	Total U	Total Cr	Be	H3	Nitrate	Gross α	Gross β	U 233/234	U 235	U 238	Pu 239/240	Am 241	Cs 137	Sr 89/90
115	Borings to confirm soil gas	Soil														
	Borings transecting plumes															
	grabs from 2' intervals	Soil														
	6' composites	Soil			X					X	X	X	X	X	X	X
	Wells downgradient of unit	Water	X		X								X	X		
	Effluent from pipes	Water	X		X								X	X		
	Sediments in SID and Woman Creek	Seds.	X		X								X	X		
	Water in SID and Woman Creek	Water	X		X								X	X		
133	Borings on 25' centers	Soil	X					X	X							
	Surface samples on 25' centers	Soil	X					X	X							
	Sediment samples downstream of ash pits	Seds.		X	X	X	X	X	X	X	X	X	X	X	X	X
	Wells downgradient of unit	Water	X		X								X	X		
142	Sediment samples in Woman Creek, SID and ponds	Seds.		X	X	X	X	X	X	X	X	X	X	X	X	X
	Water samples from ponds	Water		X	X	X	X	X	X	X	X	X	X	X	X	X
	Wells downgradient of C-1 and C-2	Water		X	X	X	X	X	X	X	X	X	X	X	X	X
209	Sediment in former ponds	Seds.	X					X	X							
	Water in former ponds	Water	X					X	X							
	Soil in small depressions	Soil	X					X	X							
SD*	Borings in area	Soil	X					X	X							
	Surface Soils	Soil	X					X	X							

* Surface disturbance south of the Ash Pits, and surface disturbance west of IHSS 209.

TABLE 7-7
(Concluded)
PHASE I ANALYTICAL PROGRAM

								Filtered									
IHSS	Location	Media	TAL Metals	TOC	TCL Vols	TCL Semi V	TCL Pest	U	Pu 239/240	Cs 137	Sr 89/90	Am 241	Pb	Total Cr	TAL Metals	Be	Anions TDS
115	Borings to confirm soil gas	Soil			X												
	Borings transecting plumes grabs from 2' intervals	Soil			X												
	6' composites	Soil	X			X											
	Wells downgradient of unit	Water	X		X	X	X	X	X	X	X	X	X	X			X
	Effluent from pipes	Water	X		X	X		X	X	X	X	X	X	X			X
	Sediments in SID and Woman Creek	Seds.	X		X	X	X	X	X	X	X	X	X	X			
	Water in SID and Woman Creek	Water	X		X	X		X	X	X	X	X	X	X			X
133	Borings on 25' centers	Soil	X														
	Surface samples on 25' centers	Soil	X	X													
	Sediment samples downstream of ash pits	Seds.	X	X													
	Wells downgradient of unit	Water	X		X	X		X	X	X	X	X				X	X
142	Sediment samples in Woman Creek, SID, and Ponds	Seds.	X	X	X	X	+										
	Water samples from ponds	Water	X		X	X		X	X	X	X	X			X	X	X
	Wells downgradient of C-1 and C-2	Water	X		X	X		X	X	X	X	X			X	X	X
209	Sediment in former ponds	Seds.	X		X	X											
	Water in former ponds	Water	X		X	X											
	Soil in small depressions	Soil	X	X	X	X											
SD*	Borings in area	Soil	X		X	X											
	Surface soils	Soil	X	X	X	X											

* Surface disturbance south of the Ash Pits.
\+ TCL pesticides will be analyzed for Ponds C-1 and C-2 sediment samples only.

The analytical parameters for the soil gas survey at IHSS 115 are 1,1,1-trichloroethane (TCA), dichloromethane, benzene, carbon tetrachloride, tetrachloroethene (PCE), and trichloroethene (TCE). Detection limits proposed for these parameters during the soil gas survey are listed in Table 7-8.

7.3.3 Sample Containers and Preservation

Sample volume requirements, preservation techniques, holding times, and container material requirements are dictated by the media being sampled and by the analyses to be performed. The soil matrices to be analyzed will include soils and sediments. The water matrices for analysis will include surface water and groundwater. Tables 7-9 and 7-10 list analytical parameters of interest in OU5 for water and soil matrices, along with the associated container size, preservatives (chemical and/or temperature), and holding times. Additional specific guidance on the appropriate use of containers and preservatives is provided in SOP FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples.

7.3.4 Sample Handling and Documentation

Sample control and documentation is necessary to ensure the defensibility of data and to verify the quality and quantity of work performed in the field. Accountable documents include logbooks, data collection forms, sample labels or tags, chain-of-custody forms, photographs, and analytical records and reports. Specific guidance defining the necessary sample control, identification, and chain-of-custody documentation is discussed in SOP FO.14.

7.3.5 Data Reporting Requirements

Field data will be input into the RFEDS environmental database using a remote data entry module supplied by EG&G. Data will be entered on a timely basis and a 3.5-inch diskette will be delivered to EG&G. A hard copy report will be generated from the module for contractor use. The data will be put through a prescribed QC process based on Standard Operating Procedure SOP FO.14 to be generated by EG&G.

A sample tracking spreadsheet will be maintained by the contractor for use in tracking sample collection and shipment. EG&G will supply the spreadsheet format and will stipulate the timely reporting of the information. This data will also be delivered to EG&G on 3.5-inch diskettes.

Computer hardware and software requirements for contractors using government supplied equipment will be supplied by EG&G. Computer and data security will also follow acceptable procedures outlined by EG&G.

TABLE 7-8
PHASE I INVESTIGATION
SOIL GAS PARAMETERS AND
PROPOSED DETECTION LIMITS

IHSS-115 Original Landfill

Volatiles	Detection Limit
1,1,1 TCA	1 $\mu g/\ell$
Dichloromethane	1 $\mu g/\ell$
Benzene	1 $\mu g/\ell$
Carbon Tetrachloride	1 $\mu g/\ell$
PCE	1 $\mu g/\ell$
TCE	1 $\mu g/\ell$

NOTE: Detection limits are a function of the detector type and injection volume. Thus, the detection limit may vary.

TABLE 7-9

SAMPLE CONTAINERS, SAMPLE PRESERVATION, AND SAMPLE HOLDING TIMES FOR WATER SAMPLES

Parameter	Container	Preservative	Holding Time
Liquid - Low to Medium Concentration Samples			
Organic Compounds:			
Purgeable Organics (VOCs)	2 x 40-mℓ VOA vials with teflon-lined septum lids	Cool, 4°C[a] with HCl to pH<2	7 days 14 days
Extractable Organics (BNAs), Pesticides and PCBs	1 x 4-ℓ amber[b] glass bottle	Cool, 4°C[a]	7 days until extraction, 40 days after extraction
Inorganic Compounds:			
Metals (TAL)	1 x 1-ℓ polyethylene bottle	Nitric acid pH<2; Cool, 4°C	180 days[c]
Cyanide	1 x 1-ℓ polyethylene bottle	Sodium hydroxide[d] pH>12; Cool, 4°C	14 days
Anions	1 x 1-ℓ polyethylene bottles	Cool, 4°C	14 days
Sulfide	1 x 1-ℓ polyethylene bottle	1 mℓ-zinc acetate sodium hydroxide to pH>9; Cool, 4°C	7 days
Nitrate	1 x 1-ℓ polyethylene bottle	Cool, 4°C	48 hours
Total Dissolved Solids (TDS)	1 x 1-ℓ polyethylene bottle	Cool, 4°C	48 hours
Radionuclides	1 x 1-ℓ polyethylene bottle	Nitric acid pH<2;	180 days

[a] Add 0.008% sodium thiosulfate ($Na_2S_2O_3$) in the presence of residual chlorine

[b] Container requirement is for any or all of the parameters given.

[c] Holding time for mercury is 28 days.

[d] Use ascorbic acid only if the sample contains residual chlorine. Test a drop of sample with potassium iodine-starch test paper; a blue color indicates need for treatment. Add ascorbic acid, a few crystals at a time, until a drop of sample produces no color on the indicator paper. Then add an additional 0.6g of ascorbic acid for each liter of sample volume.

TABLE 7-10

SAMPLE CONTAINERS, SAMPLE PRESERVATION, AND SAMPLE HOLDING TIMES FOR SOIL SAMPLES

Parameter	Container	Preservative	Holding Time
Soil or Sediment Samples - Low to Medium Concentration			
Organic Compounds:			
Purgeable Organics (VOCs)	1 x 4-oz wide-mouth teflon-lined glass vials	Cool, 4°C	14 days
Extractable Organics (BNAs), Pesticides and PCBs	1 x 8-oz wide-mouth teflon-lined glass vials	Cool, 4°C	7 days until extraction, 40 days after extraction
Inorganic Compounds:			
Metals (TAL)	1 x 8-oz wide-mouth glass jar	Cool, 4°C	180 days[1]
Cyanide	1 x 8-oz wide-mouth glass jar	Cool, 4°C	14 days
Sulfide	1 x 8-oz wide-mouth glass jar	Cool, 4°C	28 days
Nitrate	1 x 8-oz wide-mouth glass jar	Cool, 4°C	48 hours
Radionuclides	1 x 1-ℓ wide-mouth glass jar	None	45 days

[1]Holding time for mercury is 28 days.

7.4 FIELD QC PROCEDURES

Sample duplicates, field preservation blanks, and equipment rinsate blanks will be prepared. Trip blanks will be obtained from the laboratory. The analytical results obtained for these samples will be used by the Environmental Restoration (ER) Project Manager to assess the quality of the field sampling effort. The types of field QC samples to be collected and their application are discussed below. The frequency for QC samples to be collected and analyzed is provided in Table 7-11.

Duplicate samples will be collected by the sampling team and will be used as a relative measure of the precision of the sample collection process. These samples will be collected at the same time, using the same procedures, the same equipment, and in the same types of containers as required for the samples. They will also be preserved in the same manner and submitted for the same analyses as required for the samples.

Field preservation blanks of distilled water, preserved according to the preservation requirements (subsection 7.3.3), will be prepared by the sampling team and will be used to provide an indication of any contamination introduced during field sample preparation technique. As indicated by Table 7-11, these QC samples are applicable only to samples requiring chemical preservation. Equipment (rinsate) blanks will be collected from a final decontamination rinse to evaluate the success of the field sampling team's decontamination efforts on nondedicated sampling equipment.

Equipment blanks are obtained by rinsing cleaned equipment with distilled water prior to sample collection. The rinsate is collected and placed in the appropriate sample container. Equipment rinsate blanks are applicable to all analyses for water and soil samples as indicated in Table 7-11.

Trip blanks consisting of deionized water will be prepared by the laboratory technician and will accompany each shipment of water samples for volatile organic analysis. Trip blanks will be stored with the group of samples with which they are associated. Analysis of the trip blank will indicate migration of volatile organics or problems associated with the shipment, handling, or storage of the samples.

Procedures for monitoring field QC are given in the site-wide Quality Assurance Project Plan (QAPjP).

TABLE 7-11

FIELD QC SAMPLE FREQUENCY

Sample Type	Type of Analysis	Media	
		Solids	Liquids
Duplicates	Organics	1/10	1/10
	Inorganics	1/10	1/10
	Radionuclides	1/10	1/10
Field Preservation Blanks	Organics	NA	NA
	Inorganics	NA	1/20
	Radionuclides	NA	1/20
Equipment Rinsate Blanks	Organics	1/20	1/20
	Inorganics	1/20	1/20
	Radionuclides	1/20	1/20
Trip Blanks	Organics (Volatiles)	NR	1/20
	Inorganics	NR	NR
	Radionuclides	NR	NR

NA = Not Applicable
NR = Not Required

8.0
BASELINE HEALTH RISK ASSESSMENT PLAN

8.1 OVERVIEW

A baseline health risk assessment will be prepared for Operable Unit Number 5 (OU5) as part of the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) report. Both a human health evaluation and an environmental evaluation will be performed. This section describes the human health risk assessment. The environmental risk assessment is described in Section 9.0 of this Work Plan.

The purpose of the Phase I baseline risk assessment is to provide an estimate of potential health risks that may result from releases of hazardous substances from OU5 in the absence of any remedial action. Risks will be calculated for both on-site and off-site exposures to contaminants released and/or transported from the Individual Hazardous Substance Sites (IHSSs), using available data as well as data collected during the Phase I investigation of the unit.

The purpose of the baseline risk assessment is to provide information useful in determining the following, as described in the National Contingency Plan:

- A determination of whether the contaminants of concern identified at the site pose a current or potential risk to human health in the absence of any remedial action
- A determination of whether remedial action is necessary at IHSSs within the unit, and an identification of the media needing remediation
- A justification for performing remedial actions

This assessment will follow the guidance provided by the Environmental Protection Agency. It will also make use of additional information and methods that will facilitate interpretation of the results of the risk assessment. EPA publications that will be consulted when performing the health risk assessment include the following:

- Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A). Interim Final. 1989. EPA/540/1-89/002.
- Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. 1988.
- Superfund Exposure Assessment Manual. 1988. EPA/540/1-88/001.
- Exposure Factors Handbook. 1989. EPA/600/8-89/043.
- Guidance for Data Useability in Risk Assessment. Interim Final. 1990. EPA/540/G-90/008.

These documents constitute the most recent and appropriate EPA guidance on public health risk assessment. It must be emphasized that EPA manuals are guidelines only and that EPA states that considerable professional judgment must be used in their application. This risk assessment will focus on producing a realistic analysis of exposure and health risk.

The risk assessment will be accomplished in five general tasks: Task 1 - identification of contaminants of concern, Task 2 - exposure assessment, Task 3 - toxicity assessment, Task 4 - uncertainty analysis, and Task 5 - risk characterization. Each of these tasks are described below.

A separate risk assessment will be performed on each IHSS to the extent appropriate for the IHSS. Due to the separated locations, varied historical practices, and different contamination profiles, the IHSSs should receive individualized treatment. This IHSS-specific analysis will allow the identification of the most important contributors to the risk from the operable unit, and it will permit sufficient attention to be paid to contaminants that may be important at one IHSS but not at another. IHSSs that do not contribute significant risks can then be identified so that efforts may be aimed at further analysis of the significant sources of risk.

Four technical memoranda submitted to the agencies will also be part of the risk assessment program for OU5. These technical memoranda will deal with: (1) selection of indicator chemicals, (2) fate and transport model selection, (3) selection of exposure scenarios and associated assumptions and (4) identification of toxicology information to be used in the risk assessment. EPA and CDH review and approval of this series of technical memoranda should result in the agencies participation in the risk assessment process.

8.2 TASK 1 - IDENTIFICATION OF CONTAMINANTS OF CONCERN

Contaminants of concern includes chemicals and other constituents, such as metals or radionuclides, that are identified at the unit. They are the contaminants that are evaluated in the baseline risk assessment. A two-step process will be used to identify contaminants of concern. First, an initial list of contaminants of potential concern are selected on the basis of the following criteria:

- They are identified in one or more samples at the IHSS.
- They are related to activities at the IHSS; they are potentially released from an identified source in the IHSS.
- They are recognized or suspected toxicants or carcinogens.
- They are present in significant concentrations (above background).

Contaminants of potential concern will be selected following evaluation of available historical and background sampling results and the results of the Phase I field sampling proposed for OU5. Existing background data will be used to help identify contaminants that are background constituents in the environment and that are therefore not IHSS-related. Background information is expected to be available from ongoing studies including the "Background Geochemical Characterization Report, Rocky Flats Plant." (EG&G 1990c).

Available historical data on chemical and radionuclide concentrations in groundwater, surface water, sediments, soils and air near OU5 will be used in conjunction with the results of the Phase I field sampling program to identify IHSS-related chemicals of concern.

Existing analytical results taken from other sources will be accepted as suitable for risk assessment purposes. The sampling and analytical program for the Phase I investigation of OU5 is described in Section 7.0 of this Work Plan. The sampling program is designed to address all potential exposure pathways (groundwater, surface water, sediments, and soils) to the extent that they can be anticipated. Samples and analytical results obtained as part of the Phase I investigation will be collected and validated according to the Quality Assurance (QA)/Quality Control (QC) procedures described in that section. Only data validated as suitable for risk assessment purposes will be used in the risk assessment.

Tentatively Identified Compounds (TICs) will be evaluated to determine if they should be included in the risk assessment. If there are few of them in comparison to the Target Analyte List (TAL), they are normally omitted in accordance with EPA guidance.

The second step in the identification process will be followed if the number of chemicals of potential concern is high. In that case, the list may be further reduced to focus on the chemicals that pose the greatest risks at the site. Carrying a very large number of chemicals through a quantitative risk assessment can be unwieldy, time-consuming, and may obscure the dominant risks at the site. The rationale for selecting a final list of chemicals of concern will be presented in the text and will be based on the following criteria:

- historical information
- concentration, toxicity, and known synergistic effects
- mobility, persistence, and bioaccumulation
- special exposure routes
- treatability
- Applicable or Relevant and Appropriate Requirements (ARARs)
- chemical class
- frequency of detection (hits/samples)
- evaluation of essential nutrients

- concentration relative to background levels (natural or anthropogenic)
- potential for being a laboratory contaminant

The results of data collection and evaluation and selection of chemicals of concern will be summarized in the text and appropriate tables.

8.3 TASK 2 - EXPOSURE ASSESSMENT

The objective of the exposure assessment is to identify human populations (receptors) that might be exposed to chemical releases from the IHSSs and to estimate the temporal variation and magnitude of their exposure. The exposure assessment involves identifying potential receptors, identifying all potential pathways of exposure, estimating exposure point concentrations of chemicals of concern based on monitoring data and modeling results, and estimating the intake of each chemical for each pathway. The results of the exposure assessment are pathway-specific chemical intakes, expressed as mg chemical/kg body weight/day, by potentially exposed receptor populations. Exposure to radioisotopes will be expressed as activity of intake for internal exposure or as activity in environmental media for external exposure.

Conceptual models of the IHSSs will be formulated and refined based on data collected to integrate the components of the exposure assessment and clarify the pathways to be considered.

8.3.1 Potential Receptors

The exposure scenarios that will be developed in the baseline risk assessment may include exposure of potential future receptors to contaminated media within OU5 as well as exposure of off-site receptors to potentially contaminated groundwater, surface water, and airborne soil particulates. The exact exposure scenarios to be considered will be selected according to policy decisions regarding future use (e.g., residential, recreational, restricted access) of the site that may be made prior to the completion of the risk assessment. An assessment of potentially exposed populations will be conducted to assess the likelihood of a complete pathway, population characteristics and to estimate the number of humans potentially exposed. Current and proposed population dynamics will be identified and evaluated in the exposure assessment. This information will be integrated into the risk characterization.

8.3.2 Exposure Pathways

Identification of exposure pathways involves linking the source of chemical release, an environmental transport mechanism, a point of human exposure, and a mechanism of human uptake. Sources of chemical release will be sites within OU5 that contain contaminants of concern. Mechanisms of release can include leaching of chemicals from soils into groundwater or surface runoff, airborne transport of contaminated soil particulates, volatilization of organic compounds, or release of radioactive particles. Points of human exposure will be identified during the site characterization. These may include sites within the operating unit as well as off-site locations where contaminants may be transported. Examples of mechanisms of human uptake are dermal contact with contaminated media, inhalation of volatile organics or particulates, and ingestion of soils or water.

Only complete exposure pathways will be evaluated in the risk assessment. If any one of the elements of an exposure pathway (chemical source and release, environmental transport mechanism, exposure point, or uptake) is missing, the exposure pathway is considered incomplete and will not be addressed in the assessment.

8.3.3 Exposure Point Concentrations

Exposure point concentrations of contaminants of concern will be estimated using analytical results of the sample program described elsewhere in this Work Plan and available relevant historical data. Release and transport of chemicals in environmental media may be modeled using basic analytical models recommended by EPA or the best model available, as determined by a model performance evaluation. The models will be calibrated to improve performance using site-specific parameters when possible.

Model outputs will be characterized by estimating variance through an uncertainty analysis to the extent required by the overall risk uncertainty analysis. Effort will be made to reduce the variance of model output: the optimal target for model variance is that it be similar to other sources of variability in the risk assessment, including exposure factors and toxicity values.

Concentrations will also be estimated for "average" and "reasonable maximum" exposure conditions at a minimum. When feasible, a goodness-of-fit analysis will be conducted to correctly identify the distribution of the data and the most appropriate measure of central tendency. The reasonable maximum concentration will be the upper 95 percent confidence limit on the appropriate mean or maximum likelihood estimate. In calculating the media concentrations, censored data (data sets with missing values, nondetects, etc.) will be treated by appropriate methods such as those described in Gilbert, 1987 (Statistical methods for environmental pollution monitoring, Van Nostrand Reinhold).

8.3.4 Estimation of Intake

Human intakes of contaminants of concern will be estimated using reasonable estimates of exposure parameters. EPA guidance, site-specific factors, and professional judgment will be applied in establishing exposure assumptions. Using reasonable values permits estimating risks associated with the assumed exposure conditions that do not underestimate actual risk. The estimate of intake is the "intake factor," which may then be mathematically combined with the exposure point concentrations and the critical toxicity values to determine cancer risks and hazard indices.

8.4 TASK 3 - TOXICITY ASSESSMENT

The toxicity assessment is conducted to characterize the evidence regarding the potential for a contaminants of concern to cause adverse effects in exposed populations and, where possible, to estimate the relationship between the extent of exposure and the extent of adverse effects (i.e., dose-response relationship). The toxicity assessment evaluates:

- The evidence for toxic effects of the chemical
- The nature of the dose-response relationship
- The level of uncertainty in the dose-response relationship
- The primary target organs or mechanism of action for each compound of concern
- The applicability of the toxicologic data to the identified exposure scenarios

Sources of toxicity factors (cancer slope factors and reference doses) used in assessing health risks due to exposure to organic compounds, metals, and radionuclides include EPA's Integrated Risk Information System (IRIS) and the most current volume of EPA's Health Effects Assessment Summary Tables. Other sources in the public domain, such as the National Research Council's reports on the Biological Effects of Ionizing Radiation, reports IV and V, and EPA's Background Information Document, Draft E/S for Proposed National Emission Standards for Hazardous Air Pollutants (NESHAPS) for Radionuclides, will be consulted as appropriate. New toxicity data and analyses of the health risks of contaminants of concern will be considered as they become available in the literature. No new experimental toxicological data will be developed.

The toxicity assessment will include a discussion of the uncertainties inherent in the development and application of toxicity factors. The text will include a discussion of the EPA weight-of-evidence classification for carcinogens, the conservatism inherent in applying upper 95th percentile cancer slope factors, the uncertainty factors used in deriving reference doses, and other uncertainties involved in predicting human responses.

In addition, those contaminants that present the greatest risk at the site will receive additional toxicological analysis to more fully describe the potential range of appropriate critical toxicity values based on such considerations as mechanism of carcinogenesis, the validity of toxicity endpoints used to derive the RfD, or pharmakokinetic information that may provide insight on extrapolation from one species to another.

8.5 TASK 4 - QUALITATIVE AND QUANTITATIVE UNCERTAINTY ANALYSIS

Presentation of uncertainties and limitations of the risk analysis is an integral part of the risk assessment process. Usually, uncertainty is discussed after the risk characterization has been completed. However, in this risk assessment, the uncertainty analysis will provide substantial input into the risk characterization process.

Uncertainties exist primarily in the estimation and modeling of exposure point concentrations, the estimation of human exposures, and the use of toxicology data based on animal studies. These uncertainties will be described qualitatively to provide an understanding of the issues. In addition, a detailed quantitative analysis of the uncertainty will be presented to the extent practicable.

Several methods are available for quantitative analysis. The uncertainty analysis will be performed to quantify, to the extent practicable, the sources and magnitude of uncertainty in the baseline risk assessment. Quantitative techniques may include: sensitivity analysis, first-order analysis, or numerical methods such as stratified Monte Carlo sampling. The outputs will be described and interpreted in the text. This will inform the risk manager of the sufficiency of the baseline risk assessment given the level of site characterization at the conclusion of Phase I, the degree of confidence that is appropriate for the risk estimates, and a basis for further remedial activities at the site.

8.6 TASK 5 - RISK CHARACTERIZATION

Risk characterization integrates the toxicity factors for the contaminants of concern with the estimated chemical intakes and radiation exposures under the assumed exposure conditions to yield protective estimates of carcinogenic and noncarcinogenic health risks. The IHSS conceptual models will be consulted again at this point to determine realistic combinations of exposure pathways as well as maximum likelihood/reasonable maximum estimates for those pathways. Risks to receptors associated with different chemicals and exposure routes will be summed across exposure pathways that are likely to occur simultaneously in order to estimate total noncarcinogenic and carcinogenic risk from chemicals and radioisotopes. When toxicants with known mechanism of action or target organ specificity in humans can be identified, their hazards will be segregated and considered separately.

The results of the risk characterization for average, reasonable maximum, and reasonable minimum exposure conditions as determined by the uncertainty analysis will be summarized in tables and discussed in the text. The risk characterization will therefore be an unbiased estimate of risks upon which risk management decisions may be based. Populations that may be affected by the real or potential risks will be identified to the extent that is possible. These results will be discussed in the context of the output from the uncertainty analysis described above. This information will allow the risk manager to make a more informed decision on a final deterministic cleanup value.

9.0
ENVIRONMENTAL EVALUATION

9.1 INTRODUCTION

The objective of this Environmental Evaluation Work Plan is to provide a framework for addressing and quantifying the ecological effects to the biotic environment (plants, animals, microorganisms) from exposure to contaminants resulting from IHSSs within the Woman Creek Drainage, OU5. An ecosystem approach will be used as the basis for this environmental evaluation to ensure that ecological effects or endpoints (e.g., structural diversity, biomass, phenology, nutrient cycling, trophic structure) are addressed as well as populations and individuals that are more traditionally evaluated in a risk assessment approach (U.S. EPA 1989d). The ecosystem approach is comprehensive in that it initially addresses all ecosystem components, then progressively focuses on those aspects of the system potentially affected by contamination. The result of this process will be an evaluation of the nature and extent of contamination in biota, its relationship to abiotic sources, and the type and extent of adverse effects at the ecosystem, population, and individual levels of organization, as appropriate.

This plan is prepared in conformance with the requirements of current applicable legislation, including the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and follows the guidance for such studies as provided in the National Contingency Plan (NCP) and Environmental Protection Agency (EPA) documents for the conduct of Resource Conservation and Recovery Act (RCRA) Facility Investigation/ Remedial Investigation (RFI/RI) activities. Specifically, the EPA guidance provided in Risk Assessment Guidance for Superfund, Vol. II, Environmental Evaluation Manual (U.S. EPA 1989c) is followed. Although a formal Natural Resource Damage Assessment (NRDA) process has not been initiated at Rocky Flats as of this time, this work plan was also designed to be consistent with the NRDA process to the maximum extent possible.

Determination of the effects on biota will be performed in conjunction with the human health risk assessment for OU5. Where appropriate, criteria necessary for performing the environmental evaluation will be developed in conjunction with human health risk assessments and environmental evaluations for all Rocky Flats Plant operable units (OUs). Information from the environmental evaluation will assist in determining the form, feasibility, and extent of remediation necessary for Woman Creek Drainage in accordance with CERCLA.

During preparation of this work plan, several documents were reviewed as part of an assessment of available information. These included the Final Environmental Impact Statement (EIS), Rocky Flats Plant (U.S. DOE 1980); Wetlands Assessment (EG&G 1990g); Draft Environmental Evaluation Work Plan for

OU2 (in RFI/RI Work Plan, EG&G 1991d); and the Final Phase III RFI/RI Work Plan, 881 Hillside Area (U.S. DOE 1990c) among others. Literature reviews will continue throughout the environmental evaluation. Review of this Draft Phase I RFI/RI Work Plan for OU5 and the Environmental Evaluation Work Plans for OU1 (U.S. DOE 1990c) and OU2 (EG&G 1991d) formed the basis for the establishment of the initial sampling locations presented in the OU5 Environmental Evaluation Field Sampling Plan (Subsection 9.3).

9.1.1 Approach

This plan presents a comprehensive approach to conducting the environmental evaluation at Woman Creek Drainage. This comprehensive approach is designed to ensure that all procedures to be performed are appropriate, necessary and sufficient to adequately characterize the nature and extent of environmental effects to biota under the "no action" scenario. The approach presented in this plan is adapted from the toxicity-based approach to the assessment of ecosystem effects (U.S. EPA 1989c, 1989d). The approach is based on standard risk assessment concepts whereby uncertainties concerning potential ecosystem effects are explicitly recognized and, where possible, quantified. The planned approach is also based, to the greatest extent possible, on providing objective estimates of ecological damage and the establishing a firm, causal relationship between contamination and ecological effects. To establish this relationship, the Work Plan focuses on the obtainment of three types of information:

- Chemical - Chemical analyses of appropriate media to establish the presence, concentrations, and variabilities of specific toxic compounds. This effort will be conducted under the RFI/RI abiotic sampling program.
- Ecological - Ecological surveys to characterize the condition of existing communities and establish whether any adverse effects have occurred.
- Toxicological - Toxicological and ecotoxicological testing to establish the link between adverse ecological effects and known contamination.

Without these three types of data, other potential causes of the observed effects on ecosystems unrelated to the presence of contamination, such as habitat alterations and natural variability, cannot be eliminated.

The ecological assessment scheme adopted for this project blends standard environmental and risk assessment methods with ecological and toxicological modeling to produce an integrated procedure for selecting contaminants of concern and indicator species, and for conducting an investigation of ecosystem effects resulting from contamination. As is recommended by EPA, this environmental evaluation is not intended to be or to develop into a research-oriented project. The plan presented herein is designed to provide a focused investigation of potential contaminant effects on biota.

Each task of the environmental evaluation will be coordinated with RFI/RI activities at nearby operable units in order to avoid unnecessary duplication of effort and resources. Environmental evaluation planning is currently underway at two operable units in close proximity to OU5: OU1 (881 Hillside) and OU2 (903 Pad, Mound, and East Trenches Area). A coordinated approach with these operable units is necessary in order to account for contaminant migration into OU5. The environmental evaluation process has been divided into ten tasks. These tasks and their interrelationships are shown on Figure 9-1. The following is a brief description of each of these tasks. More detailed descriptions of each task are presented in Subsection 9.2.

Task 1: Preliminary Planning

Task 1 will focus on planning and coordination of the OU5 environmental evaluation with nearby OU1 and OU2 activities. Task 1 will include a determination of the scope of work and a definition of the study area. The Data Quality Objectives (DQO) process will be initiated in Task 1 according to EPA guidance (U.S. EPA 1989d), and procedures for monitoring and controlling data quality to the extent possible will be specified. Task 1 activities will include development of criteria for selection of contaminants of concern, key receptor species, and reference areas.

Task 2: Data Collection/Evaluation and Conceptual Model Development

Task 2 will include a review, evaluation, and summary of available chemical and ecological data and identification of data gaps. Based on these data, contaminants of concern will be identified based on their documented effects on key receptor species and/or other ecological endpoints. As part of the conceptual biota model development, a food web model will be constructed and preliminary exposure pathways will be identified. Results of these activities will be used to refine the ecological (Task 3) and ecotoxicological (Task 9) field investigation sampling designs.

Task 3: Ecological Field Investigation

Task 3 will include the preliminary field surveys, and an ecological field inventory to characterize OU5 biota and their trophic relationships and to note locations of obvious zones of chemical contamination. Brief field surveys will be conducted in the spring, summer, fall, and winter to obtain information on the occurrence, distribution, variability, and general abundance of key plant and animal species. Field inventories will be conducted in late spring and summer to obtain quantitative data on community composition in terrestrial and aquatic habitats. Samples collected as part of the activity will be saved for tissue analyses where contaminants of concern have been identified and sampling protocol are in place. Task 3 will also include aquatic toxicity tests using Ceriodaphnia spp, and fathead minnows. As part of these activities, all collected field data will be reduced, evaluated, compared with, and integrated into the existing database to update knowledge of site conditions.

Task 4: Toxicity Assessment

Task 4 will entail compilation of toxicity literature and the toxicological assessment of potential adverse effects from contaminants of concern on key receptor species. This task will be performed in conjunction with the following Task 5.

Task 5: Exposure Assessment and Pathways Model

Task 5 will entail development of a site-specific pathways model based on the ecological field survey. This exposure-receptor pathways model will be used to evaluate the transport of contaminants at OU5 to biological receptors. The pathways model is based on a conceptual pathways approach (Fordham and Reagan 1991) and will provide an initial determination of the movement and distribution of contaminants, likely interactions among ecosystem components, and expected ecological effects. It is anticipated that this approach will be coordinated with the efforts of investigators working in other operable units to avoid duplication of effort, to collect comparable data, and to provide a consistent assessment of contaminant effects.

Task 6: Preliminary Contamination Characterization

Task 6 will provide a characterization of the threat or risk of OU5 contaminants to receptor populations and habitats. Determinations will be made as to the magnitude of the effects of contamination on OU5 biota. The actual or potential effects of contamination on ecological endpoints (e.g., species diversity, food web structure, productivity) will also be addressed. Depending on DQOs and the quality of data collected, the contamination characterization will be expressed qualitatively, quantitatively, or a combination of the two. Task 6 may include the preliminary derivation of remediation criteria. Development of these criteria will entail consideration of federal and Colorado laws and regulations pertaining to preservation and protection of natural resources that are Applicable or Relevant and Appropriate Requirements (ARARs) (see Section 3.0). Information from ARARs, toxicological assessments, and the pathways model will be used to develop criteria that address biological resource protection.

Task 7: Uncertainty Analysis

Task 7 includes the identification of assumptions and the evaluation of uncertainty in the environmental risk assessment analysis. Task 7 will include the identification of data needs to calibrate/validate the pathways model developed in Task 5.

Task 8: Planning

Task 8 will entail the development of additional DQOs with respect to the conduct of Task 9, Ecotoxicological Field Investigation. DQOs to be achieved by such sampling will be defined according to EPA guidance (U.S. EPA 1989d). Scoping and design of Task 9 field studies will be based initially on the outcome of Tasks 1 through 3. Field sampling for assessment of injury will only be performed where acceptance criteria for demonstrating injury to a biological resource will be satisfied in accordance with regulations under the Natural Resource Damage Assessment Rule [43 CFR Subtitle A Section 11.62 (f)] and the accompanying Type B Technical Information Document (U.S. DOI 1987).

Task 9: Ecotoxicological Field Investigation

Task 9 will include tissue analysis studies and any additional ecotoxicological field investigations. Samples collected in Task 3 field studies will be used wherever possible (e.g., when contaminants of concern have been identified and sampling protocols are in place); new samples will be collected if necessary. The need for measuring additional population endpoints through reproductive success, enzyme inhibition, microbial respiration, or other ecotoxicological studies will be evaluated based on the Task 3 preliminary ecological risk assessment. Selection of the target analytes, species, and tissues will be based on the determination of which contaminants are likely to be present in sufficient concentrations, quantities, and locations as to be detected in biota. Selection of these specific criteria will be developed in consultation with EPA and the State. All necessary federal and state permits will be obtained prior to any destructive sampling or collecting.

Task 10: Environmental Evaluation Report

Task 10 will provide a final characterization of contamination in biota at OU5. Results from the Task 9 ecotoxicological field investigations will be used to evaluate ecosystem effects. Information on site environmental characteristics and contaminants, characterization of effects, remediation criteria, conclusions, uncertainty analysis, and limitations of the assessment will be summarized in the Environmental Evaluation Report.

Each of the preceding tasks is described in further detail in Subsection 9.2. A suggested outline for the Environmental Evaluation Report is presented in Subsection 9.2.11. The field sampling plan presented in Subsection 9.3 addresses both the Task 3 ecological investigation and the Task 9 ecotoxicological field investigations. A tentative outline for the environmental evaluation report is presented in Subsection 9.2.11.

9.1.2 OU5 Contamination

A number of chemicals are suspected to be present in OU5 soils, sediments, and surface water at levels above background, as described in Section 2.0 of the Phase I RFI/RI Work Plan. Preliminary reviews of available data show some chemicals (organics, metals, and radionuclides) in surface water to be above detection levels and various federal and state surface water quality standards (Tables 9-1 and 9-2). Which of these levels are above background is currently being evaluated as part of the RFI/RI effort. Most of the chemicals are likely to impact biota if present at sufficient concentrations. The following subsections present a discussion of which of these chemicals are likely to be of paramount concern at OU5, given their toxic nature. Actual selection of contaminants of concern to biota will take place in Task 2 after a more detailed analysis of potential adverse effects and review of available toxicological literature. Further comparisons of site data to the recent Background Geochemical Characterization Report (EG&G 1990c) to determine above background levels will also be made as part of the RFI/RI investigation.

9.1.2.1 Metals

Terrestrial Ecosystems

Heavy metals are the most commonly evaluated environmental contaminants in biomonitoring studies of terrestrial ecosystems. Studies on heavy metals are of several types: (1) reports of metal concentrations in animals from only one location, (2) correlations of tissue concentrations with environmental concentrations, (3) monitoring a site through time, (4) concentrations in animals collected along a gradient of pollution, and (5) comparisons of concentrations in animals from reference and contaminated sites or sites where contamination is suspected. These studies generally provide information on background concentrations of contaminants and correlations of tissue concentrations with environmental concentrations. Data from the Talmage and Walton (1990) study are available for most heavy metals for a variety of mammal species and lower trophic levels. Data from Talmage and Walton (1990) and other available studies on heavy metals effects on biota will be reviewed as part of the Task 2 effort and compared to OU5 data as appropriate.

Several of the heavy metals detected in aquatic ecosystems at OU5 are phytotoxic and are known to bioaccumulate and biomagnify in terrestrial and aquatic ecosystems. Bioaccumulation, the process by which chemicals are taken up by organisms directly or through consumption of food containing the

TABLE 9-1 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

				Statewide Standards (a)							Basin Standards (b)		Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7)						
		Maximum Surface Water Value (11)		Tables A,B Carcinogens/ Noncarcinogens (2)	Table C Aquatic Life		Tables I,II,III (1)				Organics (12)		Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radionuclide	Stream Segment Table (8)		Table 2 Radionuclides	
					Acute Value	Chronic Value	Aquatic Life Acute Value (2)	Aquatic Life Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (6)	Aquatic Life	Water Supply				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Parameter	Type (10)	Dissolved	Total																
Bicarbonate	A																		
Carbonate	A																		
Chloride	A									250,000						3	3		
Chlorine	A				3	3										3	3		
Fluoride	A									2,000									
N as Nitrate	A								100,000	10,000						10,000	10,000		
N as Nitrate+Nitrite	A								100,000	10,000									
N as Nitrite	A						SS	SS	10,000	1,000						1,000	1,000		
Sulfate	A									250,000						250,000	250,000		
Sulfide	A							2		50									
Coliform (Fecal)	B									2000/100 ml									
Ammonia as N	C						620	60		5,000						620	60		
Dioxin	D			0.00000022 (13)	0.01	0.00001							0.00000022 (13)	0.000000013			0.000000013		
Sulfur	E															2.0	2.0		
Dissolved Oxygen	FP						5,000	5,000	3,000	3,000						5,000	5,000		
pH	FP						6.5-9.0	6.5-9.0		5.0-9.0						6.5-9	6.5-9		
Specific Conductance	FP																		
Temperature	FP						30 degrees	30 degrees											
Boron	I								750							750	750		
Total Dissolved Solids	I																		
Aluminum	M	3470	99,600				950	150											
Antimony	M	61.4																	
Arsenic	M						360	150	100	50						50			
Arsenic III	M																		
Arsenic V	M																		
Barium	M	250	1470							1,000									
Beryllium	M	110	8.4						100										

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		Maximum Surface Water Value (11)		Tables A,B Carcinogens/ Noncarcin- ogens (2)	Table C Aquatic Life		Tables I,II,III (1) Aquatic Life				Organics (12)		Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radio- nuclide	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type (10)				Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul- tural Standard (3)	Domestic Water Supply (6)	Aquatic Life	Water Supply				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Cadmium	M	6.0	14.2				TVS	TVS	10	10						TVS	TVS		
Calcium	M	123,000	173,000																
Cesium	M																		
Chromium	M	30	118																
Chromium III	M						TVS	TVS	100	50						50			
Chromium VI	M						16	11	100	50						TVS	TVS		
Cobalt	M		61.8																
Copper	M	46.5	122				TVS	TVS	200							TVS	TVS		
Cyanide	M		11.5				5	5	200	1,000						5	5		
Iron	M	909	108,000					1,000		300 (dis)							300 (5)		
Lead	M	19.5	84				TVS	TVS	100	50						TVS	TVS		
Lithium	M		146																
Magnesium	M	26,000	57,700																
Manganese	M	2430	2140					1,000	200	50 (dis)							50 (5)		
Mercury	M	1.8	1.0				2.4	0.1		2.0							0.01		
Molybdenum	M	300																	
Nickel	M	820	105				TVS	TVS	200							TVS	TVS		
Potassium	M	9430	15,100																
Selenium	M	10.2	14.7				135	17	20	10						10			
Silver	M		23.3				TVS	TVS		50						TVS	TVS		
Sodium	M	91,600	81,800																
Strontium	M	600	1070																
Thallium	M							15											
Tin	M																		
Titanium	M																		
Tungsten	M																		
Vanadium	M		220																
Zinc	M	1,110	534				TVS	TVS	2,000	5,000						TVS	TVS		
2,4,5-TP Silvex	P			10									10						

TABLE 9-1 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

			Statewide Standards (a)							Basin Standards (b)		Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7)						
		Maximum Surface Water Value (11)	Tables A,B Carcinogens/ Noncarcin-ogens (2)	Table C Aquatic Life		Tables I,II,III (1) Aquatic Life				Organics (12)		Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type (10)			Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	Domestic Water Supply (6)	Aquatic Life	Water Supply				Acute Value	Chronic Value	Woman Creek	Walnut Creek
2,4-D	P		100								100	100						
Aldicarb	P		10									10						
Aldrin	P		0.002 (13)	3						0.003		0.002 (13)	0.000074			0.000074		
Bromacil	P																	
Carbofuran	P		36									36						
Chloranil	P																	
Chlordane (Alpha)	P		0.03 (13)	2.4	0.0043							0.03 (13)	0.00046			0.00046		
Chlordane (Gamma)	P		0.03 (13)	2.4	0.0043							0.03 (13)	0.00046			0.00046		
Chlorpyrifos	P			0.083	0.041													
DDT	P		0.1 (13)	1.1	0.001					0.001		0.1 (13)	0.000024			0.000024		
DDT Metabolite (DDD)	P			0.6						0.001								
DDT Metabolite (DDE)	P			1,050						0.001								
Demeton	P				0.1					0.1								
Diazinon	P																	
Dieldrin	P		0.002 (13)	2.5	0.0019					0.003		0.002 (13)	0.000071			0.000071		
Endosulfan I	P			0.22	0.056					0.003								
Endosulfan II	P																	
Endosulfan Sulfate	P																	
Endrin	P		0.2	0.18	0.0023					0.004		0.2						
Endrin Ketone	P																	
Guthion	P				0.01					0.01								
Heptachlor	P		0.008 (13)	0.52	0.0038					0.001	0.2	0.008 (13)	0.00028			0.00028		
Heptachlor Epoxide	P		0.004 (13)									0.004 (13)						
Hexachlorocyclohexane, Alpha	P												0.0092			0.0092		
Hexachlorocyclohexane, Beta	P												0.0163			0.0163		
Hexachlorocyclohexane, Delta	P																	
Hexachlorocyclohexane, Tech.	P												0.0123			0.0123		
Hexachlorocyclohexane, Lindane	P		4	2.0	0.08					0.01	4.0	4	0.0186			0.0186		
Malathion	P				0.1					0.1								
Methoxychlor	P		100		0.03					0.03	100	100						

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Parameter	Type (10)	Maximum Surface Water Value (11)	Statewide Standards (a): Tables A,B Carcinogens/Noncarcinogens (2)	Statewide Standards (a): Table C Aquatic Life: Acute Value	Statewide Standards (a): Table C Aquatic Life: Chronic Value	Statewide Standards (a): Tables I,II,III (1) Aquatic Life: Acute Value (2)	Statewide Standards (a): Tables I,II,III (1) Aquatic Life: Chronic Value (2)	Statewide Standards (a): Tables I,II,III (1) Agricultural Standard (3)	Statewide Standards (a): Tables I,II,III (1) Domestic Water Supply (6)	Basin Standards (b): Organics (12) Aquatic Life	Basin Standards (b): Organics (12) Water Supply	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7): Tables A,B (2)	Segment 4 & 5: Table C Fish & Water Ingestion	Segment 4 & 5: Table D Radionuclide	Segment 4 & 5: Stream Segment Table (8) Acute Value	Segment 4 & 5: Stream Segment Table (8) Chronic Value	Segment 4 & 5: Table 2 Radionuclides Woman Creek	Segment 4 & 5: Table 2 Radionuclides Walnut Creek
Mirex	P				620					0.001								
Parathion	P	20			0.013					0.04								
PCBs	P		0.005 (13)	2.0	0.014					0.001		0.005 (13)	0.000079			0.000079		
Simazine	P	0.81											4			4		
Toxaphene	P		5	0.73	0.0002					0.005	5.0	5						
Vaponite 2	P																	
Aroclor 1016	PP																	
Aroclor 1221	PP																	
Aroclor 1232	PP																	
Aroclor 1242	PP																	
Aroclor 1248	PP																	
Aroclor 1254	PP																	
Aroclor 1260	PP																	
Atrazine	PP	2.8											3			3		
Americium (pCi/l)	R																0.05	0.05
Americium 241 (pCi/l)	R	0.01												30				
Cesium 134 (pCi/l)	R		80 (6)									80		80			80	80
Cesium 137 (pCi/l)	R	0.6																
Gross Alpha (pCi/l)	R	18.0															7	11
Gross Beta (pCi/l)	R	45.9															5	19
Plutonium 239 (pCi/l)	R	0.06															0.05	0.05
Plutonium 238+239+240 (pCi/l)	R		15 (6)											15				
Radium 226+228 (pCi/l)	R	0.5	5 (6)											5				
Strontium 89+90 (pCi/l)	R																	
Strontium 90 (pCi/l)	R	3.5	8 (6)											8			8	8
Thorium 230+232 (pCi/l)	R		60 (6)											60				
Tritium (pCi/l)	R	990.0	20,000 (6)											20,000			500	500
Uranium 233+234 (pCi/l)	R	7.96																
Uranium 235 (pCi/l)	R	0.4																

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		Maximum Surface Water Value (11)	Tables A,B Carcinogens/ Noncarcinogens (2)	Table C Aquatic Life		Tables I,II,III (1) Aquatic Life				Organics (12)		Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radionuclide	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type (10)			Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (6)	Aquatic Life	Water Supply				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Uranium 238 (pCi/l)	R	27.0																
Uranium (Total) (pCi/l)	R	35.58				TVS	TVS							40			5	10
1,2,4,5-Tetrachlorobenzene	SV		2 (13)									2						
1,2,4-Trichlorobenzene	SV																	
1,2-Dichlorobenzene (Ortho)	SV		620									620						
1,2-Diphenylhydrazine	SV		0.05 (13)									0.05 (13)						
1,3-Dichlorobenzene (Meta)	SV		620									620						
1,4-Dichlorobenzene (Para)	SV		75									75						
2,4,5-Trichlorophenol	SV		700									700						
2,4,6-Trichlorophenol	SV		2.0 (13)		970							2.0 (13)	1.2			1.2		
2,4-Dichlorophenol	SV		21	2,020	365							21						
2,4-Dimethylphenol	SV			2,120														
2,4-Dinitrophenol	SV																	
2,4-Dinitrotoluene	SV																	
2-Chloronaphthalene	SV																	
2-Chlorophenol	SV			4,380	2,000													
2-Methylnaphthalene	SV																	
2-Methylphenol	SV	24																
2-Nitroaniline	SV																	
2-Nitrophenol	SV																	
3,3-Dichlorobenzidine	SV												0.01			0.01		
3-Nitroaniline	SV																	
4,6-Dinitro-2-methylphenol	SV																	
4-Bromophenyl Phenylether	SV																	
4-Chloroaniline	SV																	
4-Chlorophenyl Phenyl Ether	SV																	
4-Chloro-3-methylphenol	SV			30														
4-Methylphenol	SV																	
4-Nitroaniline	SV																	

TABLE 9-1 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

			Statewide Standards (a)							Basin Standards (b)		Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7)						
		Maximum Surface Water Value (11)	Tables A,B Carcinogens/ Noncarcin-ogens (2)	Table C Aquatic Life		Tables I,II,III (1) Aquatic Life				Organics (12)		Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radio-nuclide	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type (10)			Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul-tural Standard (3)	Domestic Water Supply (6)	Aquatic Life	Water Supply				Acute Value	Chronic Value	Woman Creek	Walnut Creek
4-Nitrophenol	SV																	
Acenaphthene	SV			1,700	520													
Anthracene	SV																	
Benzidine	SV		0.0002 (13)	2,500						0.1	0.01	0.0002 (13)	0.00012			0.00012		
Benzoic Acid	SV																	
Benzo(a)anthracene	SV																	
Benzo(a)pyrene	SV																	
Benzo(b)fluoranthene	SV																	
Benzo(g,h,i)perylene	SV																	
Benzo(k)fluoranthene	SV																	
Benzyl Alcohol	SV																	
bis(2-Chloroethoxy)methane	SV																	
bis(2-Chloroethyl)ether	SV		0.03 (13)									0.03 (13)	0.0000037			0.0000037		
bis(2-Chloroisopropyl)ether	SV																	
bis(2-Ethylhexyl)phthalate	SV	220																
Butadiene	SV																	
Butyl Benzylphthalate	SV																	
Chlorinated Ethers	SV																	
Chlorinated Napthalenes	SV																	
Chloroalkylethers	SV																	
Chlorophenol	SV									1.0	1.0							
Chrysene	SV																	
Dibenzofuran	SV																	
Dibenz(a,h)anthracene	SV																	
Dichlorobenzenes	SV																	
Dichlorobenzidine	SV												0.01			0.01		
Diethylphthalate	SV																	
Dimethylphthalate	SV																	
Dinitrotoluene	SV			330	230													
Di-n-butylphthalate	SV	17																

TABLE 9-1 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

			Statewide Standards (a)							Basin Standards (b)		Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7)						
		Maximum Surface Water Value (11)	Tables A,B Carcinogens/ Noncarcin- ogens (2)	Table C Aquatic Life		Tables I,II,III (1) Aquatic Life				Organics (12)		Tables A,B (2)	Table C Fish & Water Ingestion	Table D Radio- nuclide	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type (10)			Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricul- tural Standard (3)	Domestic Water Supply (6)	Aquatic Life	Water Supply				Acute Value	Chronic Value	Woman Creek	Walnut Creek
Di-n-octylphthalate	SV																	
Ethylene Glycol	SV																	
Fluoranthene	SV			3,980														
Fluorene	SV																	
Formaldehyde	SV																	
Haloethers	SV																	
Hexachlorobenzene	SV		0.02 (13)									0.02 (13)	0.00072			0.00072		
Hexachlorobutadiene	SV		14	90	9.3							14	0.45			0.45		
Hexachlorocyclopentadiene	SV		49	7	5.2							49						
Hexachloroethane	SV			980	540								1.9			1.9		
Hydrazine	SV																	
Indeno(1,2,3-cd)pyrene	SV																	
Isophorone	SV		1,050	117,000								1,050						
Naphthalene	SV			2,300	620													
Nitrobenzene	SV		3.5 (13)	27,000								3.5 (13)						
Nitrophenols	SV																	
Nitrosamines	SV																	
Nitrosodibutylamine	SV												0.0064			0.0064		
Nitrosodiethylamine	SV												0.0008			0.0008		
Nitrosodimethylamine	SV												0.0014			0.0014		
Nitrosopyrrolidine	SV												0.016			0.016		
N-Nitrosodiphenylamine	SV												4.9			4.9		
N-Nitroso-di-n-dipropylamine	SV																	
Pentachlorinated Ethanes	SV																	
Pentachlorobenzene	SV		6 (13)									6 (13)						
Pentachlorophenol	SV		200	9	5.7							200						
Phenanthrene	SV																	
Phenol	SV	15		10,200	2,560					500	1.0							
Phthalate Esters	SV																	
Polynuclear Aromatic Hydrocarbons	SV												0.0028			0.0028		

TABLE 9-1 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (10)	Maximum Surface Water Value (11)	Statewide Standards (a): Tables A,B Carcinogens/ Noncarcinogens (2)	Statewide Standards (a): Table C Aquatic Life Acute Value	Statewide Standards (a): Table C Aquatic Life Chronic Value	Statewide Standards (a): Tables I,II,III (1) Aquatic Life Acute Value (2)	Statewide Standards (a): Tables I,II,III (1) Aquatic Life Chronic Value (2)	Statewide Standards (a): Tables I,II,III (1) Agricultural Standard (3)	Statewide Standards (a): Tables I,II,III (1) Domestic Water Supply (6)	Basin Standards (b): Organics (12) Aquatic Life	Basin Standards (b): Organics (12) Water Supply	Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7): Tables A,B (2)	Segment 4 & 5: Table C Fish & Water Ingestion	Segment 4 & 5: Table D Radio-nuclide	Segment 4 & 5: Stream Segment Table (8) Acute Value	Segment 4 & 5: Stream Segment Table (8) Chronic Value	Segment 4 & 5: Table 2 Radionuclides Woman Creek	Segment 4 & 5: Table 2 Radionuclides Walnut Creek
Vinyl Chloride	SV		2									2						
1,1,1-Trichloroethane	V	7	200									200						
1,1,2,2-Tetrachloroethane	V				2,400								0.17			0.17		
1,1,2-Trichloroethane	V		28		9,400							28	0.60			0.60		
1,1-Dichloroethane	V																	
1,1-Dichloroethene	V		7									7						
1,2-Dichloroethane	V	11	5	118,000	20,000							5						
1,2-Dichloroethene (cis)	V		70									70						
1,2-Dichloroethene (total)	V																	
1,2-Dichloroethene (trans)	V		70									70						
1,2-Dichloropropane	V		0.56 (13)	23,000	5,700							0.56 (13)						
1,3-Dichloropropene (cis)	V			6,060	244													
1,3-Dichloropropene (trans)	V			6,060	244													
2-Butanone	V	25																
2-Hexanone	V																	
4-Methyl-2-pentanone	V																	
Acetone	V	27																
Acrylonitrile	V			7,550	2,600								0.058			0.058		
Benzene	V		5	5,300								5						
Bromodichloromethane	V																	
Bromoform	V																	
Bromomethane	V																	
Carbon Disulfide	V	6																
Carbon Tetrachloride	V	7	5	35,200								5						
Chlorinated Benzenes	V																	
Chlorobenzene	V		300									300						
Chloroethane	V																	
Chloroform	V	21	Tot THM <100 (4)	28,900	1,240							Tot THM <100 (4)	0.19			0.19		

TABLE 9-1 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO STATE (CDH/WQCC) SURFACE WATER QUALITY STANDARDS (ug/l)

			Statewide Standards (a)							Basin Standards (b)		Segment 4 & 5 Stream Classification and Water Quality Standards (b)(7)						
			Tables A,B	Table C		Tables I,II,III (1)												
				Aquatic Life		Aquatic Life				Organics (12)		Tables A,B	Table C	Table D	Stream Segment Table (8)		Table 2 Radionuclides	
Parameter	Type (10)	Maximum Surface Water Value (11)	Carcinogens/ Noncarcinogens (2)	Acute Value	Chronic Value	Acute Value (2)	Chronic Value (2)	Agricultural Standard (3)	Domestic Water Supply (6)	Aquatic Life	Water Supply	(2)	Fish & Water Ingestion	Radionuclide	Acute Value	Chronic Value	Woman Creek	Walnut Creek
Chloromethane	V																	
Dibromochloromethane	V																	
Dichloroethenes	V																	
Ethyl Benzene	V		680	32,000								680						
Ethylene Dibromide	V																	
Ethylene Oxide	V																	
Halomethanes	V		100									100	0.19			0.19		
Methylene Chloride	V	21																
Pyrene	V																	
Styrene	V																	
Tetrachloroethanes	V												0.8			0.8		
Tetrachloroethene	V	13	10	5,280	840							10						
Toluene	V	12	2,420	17,500								2,420						
Trichloroethanes	V																	
Trichloroethene	V	42	5	45,000	21,900							5						
Vinyl Acetate	V																	
Xylenes (Total)	V	6																

EXPLANATION OF TABLE

CLP = Contract Laboratory Program
CDH = Colorado Department of Health
dis = dissolved
EPA = Environmental Protection Agency
pCi/l = picocuries per liter
PCB = polychlorinated biphenyl
PQL = Practical Quantitation Level
SS = species specific
TAL = Target Analyte List
THM = Total Trihalomethanes

TIC = Tentatively Identified Compound
TVS = Table Value Standard (hardness dependent), see Table III in (a)
MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis
WQCC = Water Quality Control Commission

(1) Table I = physical and biological parameters
Table II = inorganic parameters
Table III = metal parameters
Values in Tables I, II, and III for recreational uses, cold water biota and domestic water supply are not included.
(2) In the absence of specific, numeric standards for non-naturally occurring organics, the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/WQCC or EPA
(3) All are 30-day standards except for nitrate+nitrite
(4) Total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(5) Lowest value given: dissolved or total recoverable
(6) Ammonia, sulfide, chloride, sulfate, copper, iron, manganese, and zinc are 30-day standards, all others are 1-day standards
(7) Segment 4 standards for inorganics, metals, organics, and radionuclides are TBC and Segment 5 standards are goals (TBCs)
(8) Includes Table 1: Additional Organic Chemical Standards (chronic only)
(9) See section 3.1.11 (f)(2) in (a)
(10) type abbreviations are: A=anion; B=bacteria; C=cation; I=indicator; FP=field parameter; M=metal; P= pesticide; PP=pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile
(11) Data for metals and organics is from Appendix E; data for radionuclides is from EG&G's analytical database for surface water samples.
(12) See Section 3.8.5 (2)(a) in (b)
(13) Standard is below (more stringent than) PQL, therefore PQL is standard.
(14) MDL for Radium 226 is 0.5; MDL for Radium 228 is 1.0

(a) CDH/WQCC, Colorado Water Quality Standards 3.1.0 (5 CCR 1002-8) 1/15/1974; amended 9/30/1989 (Envrionmental Reporter 726:1001-1020:6/1990)
(b) CDH/WQCC, Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8.0 (5 CCR 1002-8) 4/6/1981; amended 2/15/1990

TABLE 9-2 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	Maximum Surface Water Values (8)		SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c)		CWA AWQC for Protection of Human Health/TBCs (c)	
		Dissolved	Total					Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Bicarbonate	A										
Carbonate	A										
Chloride	A			250,000*				860,000(e)	230,000(e)		
Chlorine	A							19	11		
Flouride	A			4,000; 2,000*		4,000					4,000
N as Nitrate	A			10,000			10,000			10,000	
N as Nitrate+Nitrite	A				10,000		10,000				
N as Nitrite	A				1,000		1,000				
Sulfate	A			250,000*							
Sulfide	A										
Coliform (Fecal)	B			1/100 ml							
Ammonia as N	C							Criteria are pH	and temperature	dependent – see	criteria document
Dioxin	D							0.01	0.00001	0.000000013	0.000000014
Sulfur	E										
Dissolved Oxygen	FP							5,000			
pH	FP			6.5–8.5 *					6.5–9		
Specific Conductance	FP										
Temperature	FP							SS	SS		
Boron	I										
Total Dissolved Solids	I			500,000*				SS	SS	250,000	
Aluminum	M	3470	99,600		50 to 200*			750	87		
Antimony	M	61.4						9,000	1,600	146	45,000
Arsenic	M			50						.0022	.0175
Arsenic III	M							360	190		
Arsenic V	M							850	48		
Barium	M	250	1470	1,000	2,000 (f)		2,000 (f)			1,000	
Beryllium	M	110	8.4					130	5.3	.0068**	.117**
Cadmium	M	6.0	14.2	10	5		5	3.9 (3)	1.1 (3)	10	

TABLE 9-2 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	Maximum Surface Water Values (8)		SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c)		CWA AWQC for Protection of Human Health/TBCs (c)	
								Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Calcium	M	123,000	173,000								
Cesium	M										
Chromium	M	30	118	50	100		100				
Chromium III	M							1,700	210	170,000	3,433,000
Chromium VI	M							16	11	50	
Cobalt	M		61.8								
Copper	M	46.5	122	1,000*			1,3000 (f)	18 (3)	12 (3)		
Cyanide	M		11.5					22	5.2	200	
Iron	M	909	108,000	300 *					1,000	300	
Lead	M	19.5	84	50			0 (g)	82 (3)	3.2 (3)	50	
Lithium	M		146								
Magnesium	M	26,000	57,700								
Manganese	M	2430	2140	50 *						50	100
Mercury	M	1.8	1.0	2	2		2	2.4	0.012	0.144	0.146
Molybdenum	M	300									
Nickel	M	820	105					1,400 (3)	160 (3)	13.4	100
Potassium	M	9430	15,100								
Selenium	M	10.2	14.7	10	50		50	20 (d)	5 (d)	10	
Silver	M		23.3	50	100 •			4.1 (3)	0.12	50	
Sodium	M	91,600	81,800								
Strontium	M	600	1070								
Thallium	M							1,400 (1)	40 (1)	13	48
Tin	M										
Titanium	M										
Tungsten	M										
Vanadium	M		220								
Zinc	M	1,110	534	5,000 *				120 (3)	110 (3)		
2,4,5-TP Silvex	P			10	50		50				
2,4-Dichlorophenoxyacetic Acid (2,4-D)	P			100	70		70				

TABLE 9-2 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	Maximum Surface Water Values (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only
Aldicarb	P			3 (f)		1 (f)				
Aldrin	P						3.0		0.000074	0.000079
Bromacil	P									
Carbofuran	P			40		40				
Chloranil	P									
Chlordane (Alpha)	P			2		0	2.4	0.0043	0.00046	0.00048
Chlordane (Gamma)	P			2		0	2.4	0.0043	0.00046	0.00048
Chlorpyrifos	P						0.063	0.041		
DDT	P						1.1	0.0011	0.000024	0.000024
DDT Metabolite (DDD)	P						0.06			
DDT Metabolite (DDE)	P						1,050			
Demeton	P							0.1		
Diazinon	P									
Dieldrin	P						2.5	0.0019	0.00007	0.000076
Endosulfan I	P						0.22	0.056	74	159
Endosulfan II	P									
Endosulfan Sulfate	P									
Endrin	P		0.2				0.18	0.0023	1	
Endrin Ketone	P									
Guthion	P							0.01		
Heptachlor	P			0.4		0	0.52	0.0038	0.00028	0.00029
Heptachlor Epoxide	P			0.2		0				
Hexachlorocyclohexane, Alpha	P								0.0092	0.031
Hexachlorocyclohexane, Beta	P								0.0163	0.0547
Hexachlorocyclohexane, Delta	P									
Hexachlorocyclohexane, Technical	P								0.0123	0.0414
Hexachlorocyclohexane, (Lindane) Gama	P		4	0.2		0.2	2.0	0.08		
Malathion	P							0.01		
Methoxychlor	P		100	40		40		0.03	100	
Mirex	P							0.001		

TABLE 9-2 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	Maximum Surface Water Values (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only
Parathion	P	20					0.065	0.013		
PCBs	P			0.5		0	2.0	0.014	0.000079	0.000079
Simazine	P	0.81								
Toxaphene	P			3		0	0.73	0.0002	0.0071	0.00073
Vaponite 2	P									
Aroclor 1016	PP									
Aroclor 1221	PP									
Aroclor 1232	PP									
Aroclor 1242	PP									
Aroclor 1248	PP									
Aroclor 1254	PP									
Aroclor 1260	PP									
Atrazine	PP	2.8		3		3				
Americium (pCi/l)	R									
Americium 241 (pCi/l)	R	0.01								
Cesium 134 (pCi/l)	R									
Cesium 137 (pCi/l)	R	0.6								
Gross Alpha (pCI/l)	R	18.0	15 (10)							15
Gross Beta (pCi/l)	R	45.9	50 (4 mrem/yr)							
Plutonium (pCi/l)	R	0.06								
Plutonium 238+239+240 (pCi/l)	R									
Radium 226+228 (pCi/l)	R	0.5	5							5
Strontium 89+90 (pCi/l)	R									
Strontium 90 (pCi/l)	R	3.5	8 (6)							8
Thorium 230+232 (pCi/l)	R									
Tritium (pCi/l)	R	990.0	20,000 (6)							
Uranium 233+234 (pCi/l)	R	7.96								
Uranium 235 (pCi/l)	R	0.4								
Uranium 238 (pCi/l)	R	27.0								

TABLE 9-2 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	Maximum Surface Water Values (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only
Uranium (Total) (pCi/l)	R	35.58								
1,2,4,5-Tetrachlorobenzene	SV								38	48
1,2,4-Trichlorobenzene	SV									
1,2-Dichlorobenzene (Ortho)	SV			600		600				
1,2-Diphenylhydrazine	SV						270 (1)			
1,3-Dichlorobenzene (Meta)	SV									
1,4-Dichlorobenzene (Para)	SV		75		75					
2,4,5-Trichlorophenol	SV								2,800	
2,4,6-Trichlorophenol	SV							970 (1)	1.2 **	3.6 **
2,4-Dichlorophenol	SV						2,020 (1)	365 (1)	3,090	
2,4-Dimethylphenol	SV						2,120 (1)			
2,4-Dinitrophenol	SV									
2,4-Dinitrotoluene	SV								0.11 **	9.1 **
2-Chloronaphthalene	SV									
2-Chlorophenol	SV						4,360 (1)	2,000 (1)		
2-Methylnaphthalene	SV									
2-Methylphenol	SV	24								
2-Nitroaniline	SV									
2-Nitrophenol	SV									
3,3-Dichlorobenzidine	SV								0.01	0.02
3-Nitroaniline	SV									
4,6-Dinitro-2-methylphenol	SV									
4-Bromophenyl Phenylether	SV									
4-Chloroaniline	SV									
4-Chlorophenyl Phenyl Ether	SV									
4-Chloro-3-methylphenol	SV						30 (1)			
4-Methylphenol	SV									
4-Nitroaniline	SV									
4-Nitrophenol	SV						230 (1)	150 (1)		

TABLE 9-2 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	Maximum Surface Water Values (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only
Acenaphthene	SV						1,700 (1)	520 (1)		
Anthracene	SV									
Benzidine	SV						2,500		0.00012	0.00053
Benzoic Acid	SV									
Benzo(a)anthracene	SV									
Benzo(a)pyrene	SV									
Benzo(b)fluoranthene	SV									
Benzo(g,h,i)perylene	SV									
Benzo(k)fluoranthene	SV									
Benzyl Alcohol	SV									
bis(2-Chloroethoxy)methane	SV									
bis(2-Chloroethyl)ether	SV								0.03**	1.36 **
bis(2-Chloroisopropyl)ether	SV								34.7	4,360
bis(2-Ethylhexyl)phthalate	SV	220							15,000	50,000
Butadiene	SV									
Butylbenzylphthalate	SV									
Chlorinated Ethers	SV									
Chlorinated Napthalenes	SV						1,600 (1)			
Chloroalkylethers	SV						238,000 (1)			
Chlorophenol	SV									
Chrysene	SV									
Dibenzofuran	SV									
Dibenz(a,h)anthracene	SV									
Dichlorobenzenes	SV						1,120 (1)	763 (1)	400	2,600
Dichlorobenzidine	SV								0.01	0.02
Diethylphthalate	SV								350,000	1,800,000
Dimethylphthalate	SV								313,000	2,900,000
Dinitrotoluene	SV						330 (1)	230 (1)	70	14,300
Di-n-butylphthalate	SV	17								
Di-n-octylphthalate	SV									

TABLE 9-2 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	Maximum Surface Water Values (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only
Ethylene glycol	SV									
Fluoranthene	SV						3,980 (1)		42	54
Fluorene	SV									
Formaldehyde	SV									
Haloethers	SV						380 (1)	122 (1)		
Hexachlorobenzene	SV								0.00072**	0.00074**
Hexachlorobutadiene	SV						90 (1)	9.3 (1)	0.45**	50 **
Hexachlorocyclopentadiene	SV						7 (1)	5.2 (1)	206	
Hexachloroethane	SV						980 (1)	540 (1)	1.9	8.74
Hydrazine	SV									
Indeno(1,2,3-cd)pyrene	SV									
Isophorone	SV						117,000 (1)		5,200	520,000
Naphthalene	SV						2,300 (1)	620 (1)		
Nitrobenzene	SV						27,000 (1)		19,800	
Nitrophenols	SV						230 (1)	150 (1)		
Nitrosamines	SV						5,850 (1)			
Nitrosodibutylamine	SV								0.0064	0.587
Nitrosodiethylamine	SV								0.0008	1.24
Nitrosodimethylamine	SV								0.0014	16
Nitrosopyrrolidine	SV								0.016	91.9
N-Nitrosodiphenylamine	SV								4.9 **	16.1 **
N-Nitroso-di-n-dipropylamine	SV									
Pentachlorinated Ethanes	SV						7,240 (1)	1,100 (1)		
Pentachlorobenzene	SV								74	85
Pentachlorophenol	SV			1 (f)		0 (f)	20 (4)	13 (4)	1,010	
Phenanthrene	SV									
Phenol	SV	15					10,200 (1)	2,560 (1)	3,500	
Phthalate Esters	SV						940 (1)	3 (1)		
Polynuclear Aromatic Hydrocarbons	SV								0.0028**	0.0311**
Vinyl Chloride	SV		2		0				2 **	525 **

TABLE 9-2 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	Maximum Surface Water Values (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c) Acute Value	CWA AWQC for Protection of Aquatic Life/TBCs (c) Chronic Value	CWA AWQC for Protection of Human Health/TBCs (c) Water and Fish Ingestion	CWA AWQC for Protection of Human Health/TBCs (c) Fish Consumption Only
1,1,1-Trichloroethane	V	7	200		200				18,400	1,030,000
1,1,2,2-Tetrachloroethane	V							2,400	0.17**	10.7 **
1,1,2-Trichloroethane	V							9,400	0.6**	41.8 **
1,1-Dichloroethane	V									
1,1-Dichloroethene	V		7		7					
1,2-Dichloroethane	V	11	5		0		118,000	20,000	0.94**	243 **
1,2-Dichloroethene (cis)	V			70		70				
1,2-Dichloroethene (total)	V									
1,2-Dichloroethene (trans)	V			100		100				
1,2-Dichloropropane	V			5		0	23,000	5,700		
1,3-Dichloropropene (cis)	V						6,060	244 (1)	87	14,100
1,3-Dichloropropene (trans)	V						6,060	244 (1)	87	14,100
2-Butanone	V	25								
2-Hexanone	V									
4-Methyl-2-pentanone	V									
Acetone	V	27								
Acrylonitrile	V						7,500	6,000	0.058	0.65
Benzene	V		5		0		5,300		0.66**	40 **
Bromodichloromethane	V									
Bromoform	V									
Bromomethane	V									
Carbon Disulfide	V	6								
Carbon Tetrachloride	V	7	5		0		35,200 (1)		0.4**	6.94 **
Chlorinated Benzenes	V						250 (1)	50 (1)		
Chlorobenzene	V			100		100				
Chloroethane	V									
Chloroform	V	21	Tot THM<100 (2				28,900 (1)	1,240 (4)	0.19 **	15.7 **
Chloromethane	V									
Dibromochloromethane	V									

TABLE 9-2 COMPARISON OF MAXIMUM SURFACE WATER VALUES TO FEDERAL SURFACE WATER QUALITY STANDARDS (ug/l)

Parameter	Type (7)	Maximum Surface Water Values (8)	SDWA Maximum Contaminant Level (a)	SDWA Maximum Contaminant Level TBCs (b)	SDWA Maximum Contaminant Level Goal (a)	SDWA Maximum Contaminant Level Goal TBCs (b)	CWA AWQC for Protection of Aquatic Life/TBCs (c)		CWA AWQC for Protection of Human Health/TBCs (c)	
							Acute Value	Chronic Value	Water and Fish Ingestion	Fish Consumption Only
Dichloroethenes	V						11,600 (1)		0.033**	1.85 **
Ethyl Benzene	V			700		700	32,000 (1)		1,400	3,280
Ethylene Dibromide	V			0.05		0				
Ethylene Oxide	V									
Halomethanes	V		100				11,000 (1)		0.19**	15.7 **
Methylene Chloride	V	21								
Pyrene	V									
Styrene	V			100		100				
Tetrachloroethanes	V						9,320 (1)			
Tetrachloroethene	V	13		5		0	5,280 (1)	840 (1)	0.80**	8.85 **
Toluene	V	12		1,000		1,000	17,500 (1)		14,300	424,000
Trichloroethanes	V						18,000 (1)			
Trichloroethene	V	42	5		0		45,000 (1)	21,900 (1)	2.7 **	80.7 **
Vinyl Acetate	V									
Xylenes (total)	V	6		10,000		10,000				

EXPLANATION OF TABLE

* = secondary maximum contaminant level, TBCs

** = Human health criteria for carcinogens reported for three risk levels. Value presented is the 10–5 risk level.

AWQC = Ambient Water Quality Criteria
CLP = Contract Laboratory Program
CWA = Clean Water Act
EPA = Environmental Protection Agency
pCi/l = picocuries per liter
PCB = polychlorinated biphenyl
PQL = Practical Quantitation Level
SDWA = Safe Drinking Water Act
SS = Species Specific

TAL = Target Analyte List
THM = Total Trihalomethanes
TIC = Tentatively Identified Compound
MDL = Minimum Detection Limit for radionuclides (pCi/l)
ug/l = micrograms per liter
VOA = Volatile Organic Analysis

(1) criteria not developed; value presented is lowest observed effects level (LOEL)
(2) total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane
(3) hardness dependent criteria
(4) pH dependent criteria (7.8 pH used)
(5) standard is not adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium.
(6) if both strontium-90 and tritium are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 mrem/yr.
(7) type abbreviations are: A=anion; B=bacteria; C=cation; I=indicator; FP=field parameter; M=metal; P=Pesticide; PP=Pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile
(8) Data for metals and organics is from Appendix E; data for radionuclides is from EG&G's analytical database for surface water samples.
(9) MDL for radium 226 is 0.5; MDL for radium 228 is 1.0
(10) Value for gross alpha excludes uranium

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of May 1990)
(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142 and 143, Final Rule, effective July 30, 1992
(c) EPA, Quality Criteria for Protection of Aquatic Life, 1986
(d) EPA, National Ambient Water Quality Criteria for Selenium - 1987
(e) EPA, National Ambient Water Quality Criteria for Chloride - 1988
(f) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, and 143, Final Rule (56 FR 30266; 7/1/1991) effective 1/1/1993.
(g) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142 (56 FR 26460; 6/7/1991) effective 11/6/1991.

chemicals, is documented for arsenic, cadmium, chromium, cobalt, copper, lead, mercury, nickel, and selenium. Biomagnification, or the process by which tissue concentrations of chemicals increase as the chemical passes up through two or more trophic levels, is documented from soil to plants for beryllium, cadmium, chromium, copper, lead, mercury, and selenium. In herbivores, biomagnification occurs for antimony, arsenic, cadmium, chromium, copper, lead, mercury and selenium. In terrestrial carnivores, mercury and cadmium are known to biomagnify. Any, if not all, of these metals are likely to become contaminants of concern in the OU5 environmental evaluation depending on historical usage, concentrations detected in soils, and potential uptake by biological receptors at OU5.

Aquatic Ecosystems

EPA (U.S. EPA 1986b) and the State have established ambient water quality criteria (AWQC) to be protective of the environment (see Section 3.0 and Tables 3-2 and 3-3). Specifically, these criteria represent the maximum allowable water concentrations consistent with the protection of aquatic wildlife. One rationale for establishing criteria protective of aquatic life is that aquatic organisms and plants are important in food chains to higher life forms. In addition, their direct dependence on the aquatic environment results in constant contact with the water and the organisms are therefore likely to assimilate any contaminants. One EPA objective in establishing AWQC was to determine chemical concentrations that would not be directly harmful to aquatic organisms and plants and would not present a hazard to higher life forms due to any biomagnification of individual chemical substances.

Of the maximum levels of metals detected in surface water at OU5 (see Appendix E), a number are of immediate interest in the evaluation of aquatic ecosystems given their presence at levels above federal and state surface water quality standards (Tables 9-1 and 9-2). Metals with maximum values exceeding Federal AWQC for protection of aquatic life include: aluminum, beryllium, cadmium, copper, cyanide, iron, lead, mercury, nickel, selenium, silver, and zinc. Chromium may also be of concern, depending on the fraction of total chromium as chromium VI. Several of these metals are of further concern in that they exceed Federal MCLs and AWQC for the protection of human health. Metals with values exceeding MCLs or SMCLs include aluminum, barium, cadmium, chromium, iron, lead, manganese, and selenium. Metals with maximum surface water values exceeding AWQC for the protection of human health include barium, beryllium, cadmium, iron, lead, manganese, mercury, and nickel. Metals that were detected at OU5 for which there are no federal surface water standards include calcium, cobalt, lithium, magnesium, molybdenum, potassium, sodium, strontium, and vanadium.

Metals with maximum surface water values exceeding either Colorado statewide standards, basin standards, or stream segment standards for the protection of aquatic life include aluminum, cyanide, iron, manganese, mercury, and selenium. Cadmium, chromium, lead, nickel, silver, and zinc may also be of concern depending on the site-specific table value standard. Metals which do not exceed state AWQC or metals which have no state AWQC standards, but exceed other state criteria include barium and beryllium. Metals for which there are no state surface water standards include antimony, calcium, cobalt, lithium, magnesium, potassium, sodium, strontium, and vanadium. Of the metals detected at OU5, aluminum, cadmium, chromium, copper, lead, mercury, selenium, and zinc are likely to be contaminants of concern because of their potential to biomagnify. Brief summaries of information from the AWQC document (U.S. EPA 1986b) and other available toxicological literature on these metals of likely concern are presented in the following text. Similar toxicity profiles will be evaluated against site-specific concentrations data in the selection of contaminants of concern and key receptor species by the Risk Assessment Technical Working Group.

In addition to the metals, the toxicity to biota from nutrient loading of organic, nitrogen, and phosphate species, as well as ammonia, will be evaluated. The occurrence of these nutrients or metals at elevated levels does not necessarily imply that toxic conditions exist or adverse effects are likely to occur in the aquatic ecosystem. The potential for adverse effects to occur is dependent on a number of physiochemical factors including: (1) physiological and ecological characteristics of the organism; (2) forms of dissolved trace metals; (3) forms of trace metals in ingested solids; and (4) chemical and physical characteristics of water (Jenne and Luoma 1977). Each of these factors will be considered in the evaluation of potential adverse environmental effects at OU5.

Aluminum

The toxicity of aluminum to freshwater aquatic organisms appears to be due primarily to the simple hydroxide forms of aluminum and is dependent upon the pH. Acute toxicity values for aluminum are available for several freshwater animal species; these values range from 1,900 μg/l for a cladoceran to 79,900 μg/l for a midge. The range of concentrations of aluminum that are acutely toxic to freshwater invertebrates is about the same as the range of concentrations that are toxic to fish. These species include a wide variety of animals that perform a wide spectrum of ecological functions.

The chronic values for aluminum have been determined with three freshwater species. Chronic tests using Ceriodaphnia dubia showed reduced survival and reproduction at concentrations of 2,600 μg/l. Tests using Daphnia magna showed reduced survival at concentrations of 1,020 μg/l. Tests using fathead minnows showed reduced weight by 11.4% at concentrations of 4,700 μg/l and by 7.1% at concentrations of 2,300 μg/l. However, survival at both concentrations was as good or better than in the control treatment. These chronic tests indicate that, of the three species tested, the invertebrates are more sensitive to aluminum than the vertebrates. Other data have shown that concentrations of 169 μg/l cause a 24% reduction in the weight of young brook trout, and concentrations of 88 μg/l cause a 4% reduction in weight. In a 7-day test, concentrations of 174.4 μg/l killed 58% of the exposed striped bass. Bioconcentration factors for aluminum range from 50 to 231.

Cadmium

Freshwater acute values for cadmium are available for species in 44 genera and range from 1.0 μg/l for rainbow trout to 28,000 μg/l for a mayfly. The antogonistic effect of hardness on acute toxicity has been demonstrated with five species. Chronic tests have been conducted on 12 freshwater fish species and 4 invertebrate species; chronic values range from 0.15 μg/l for Daphnia magna to 156 μg/l for the Atlantic salmon. Freshwater aquatic plants are affected by cadmium at concentrations ranging from 2 to 7,400 μg/l. These values are in the same range as the acute toxicity values for fish and invertebrate species, and are considerably above the chronic values. Bioconcentration factors (BCFs) for cadmium in fresh water range from 164 to 4,190 for invertebrates and from 3 to 2,213 for fish.

Chromium(VI)

The toxicity of chromium is largely due to its oxidizing action in its hexavalent state (as chromic oxide, chromate, or dichromate) and its easy permeation of biologic membranes (NRC 1974). Acute toxicity values for chromium(VI) are available for freshwater animal species in 27 genera; these values range from 23.07 μg/l for a cladoceran to 1,870,000 μg/l for a stonefly. These species include a wide variety of animals that perform a wide spectrum of ecological functions. Daphnids are especially sensitive. The few data that are available indicate that the acute toxicity of chromium(VI) decreases as hardness and pH increase.

The chronic value for both rainbow trout and brook trout is 264.6 μg/l; while the chronic value for fathead minnow is 1,987 μg/l. Chronic tests using chinook salmon show a reduction in growth at low concentrations of 16 μg/l. Chronic values in soft water for daphnids range from <2.5 to 40 μg/l and acute-chronic ratios range from 1.130 to >9.680. Green algae are quite sensitive to chromium(VI). The bioconcentration factor (BCF) for rainbow trout is less than 3.

Copper

The toxicity of copper to aquatic organisms is due primarily to the cupric (Cu^{2+}) ion and possibly to some of the hydroxy complexes. Concentrations of copper ranging from 1 to 8,000 μg/l inhibit growth of various aquatic plant species. Sensitivities for aquatic invertebrates and fish are similar to those for plants. Acute toxicity data are available for species in 41 genera of freshwater animals. At a hardness of 50 mg/ℓ, the genera range in sensitivity from 16.74 μg/l for Ptychocheilus to 10,240 μg/l for Acroneuria. Acute toxicity generally decreases as water hardness increases. Additional data for several species indicate that toxicity also decreases with increases in alkalinity and total organic carbon. Chronic values are available for 15 freshwater fish species and range from 3.87 μg/l for brook trout to 60.36 μg/l for northern pike. Fish and invertebrate species seem to be equally sensitive to the chronic toxicity of copper.

Protection of animal species appears to offer adequate protection of plants. Copper does not appear to bioconcentrate very much in the edible portion of freshwater aquatic species. Many animals have some ability to cope with excess copper through excretion (Rand and Petrocelli 1985). In animals where copper is not excreted, copper will accumulate in tissues, especially in the liver.

Lead

The acute toxicity of lead to several species of freshwater animals has been shown to decrease as the hardness of water increases. At a hardness of 50 mg/l, the acute sensitivities range from 142.5 μg/l for an amphipod to 235,900 μg/l for a midge. Data on the chronic effects of lead on freshwater animals are available for two fish and two invertebrate species. The lowest and highest available chronic values (12.26 and 128.1 μg/l) are both for a cladoceran, but in soft and hard water respectively. Freshwater algae are affected by concentrations of lead above 500 μg/l, based on data for four species. BCFs are available for four invertebrate and two fish species and range from 42 to 1,700.

Several enzymes are sensitive to lead at very low concentrations. Lead strongly inhibits several ATPases, lipoamide dehydrogenase, and aminolevulinic acid dehydratase, which is involved in the synthesis of heme (Rand and Petrocelli 1985). In vertebrate animals, lead poisoning is characterized by neurological defects, kidney dysfunction, and anemia.

Mercury

Mercury is toxic to all forms of biota in aquatic ecosystems, although many factors (e.g., alkalinity, pH, and temperature) influence toxicity. The toxic action of mercury in plants and animals appears to involve cell membranes and their permeability. In mammals, early subacute poisoning generally has a neurological manifestation (Rand and Petrocelli 1985). Data are available on the acute toxicity of mercury(II) to 28 genera of freshwater animals. Acute values for invertebrate species range from 2.2 μg/l for Daphnia pulex to 2,000 μg/l for three insects. Acute values for fish range from 30 μg/l for the guppy to 1,000 μg/l for Mozambique tilapia. Few data are available for various organomercury compounds and mercurous nitrate, which are 4 to 31 times more acutely toxic than mercury(II).

Available chronic data indicate that methylmercury is the most chronically toxic of the tested mercury compounds. Tests on methylmercury with Daphnia magna and brook trout show chronic values less than 0.07 μg/l. For mercury(II), the chronic value for Daphnia magna is about 1.1 μg/l and the acute-chronic ratio (median lethal concentration sufficient to produce short term effects/concentration producing effects after long term exposure) is 4.5. In both a life-cycle test and an early life-stage test on mercuric chloride with the fathead minnow, the chronic value was less than 0.26 μg/l and the acute-chronic ratio was over 600.

Freshwater plants show a wide range of sensitivities to mercury, but the most sensitive plants appear to be less sensitive than the most sensitive freshwater animals to both mercury(II) and methylmercury. A BCF of 4,994 is available for mercury(II); BCFs for methylmercury range from 4,000 to 85,000.

Selenium

Although selenium can be quite toxic, it has been shown to be an essential trace nutrient for many aquatic and terrestrial species and it has been shown to ameliorate the effects of a variety of pollutants (e.g., arsenic, cadmium, copper, and mercury). Invertebrates have been shown to be both the most sensitive and the most resistant freshwater species to selenium(IV). Acute values for Daphnia spp. range from 6 μg/l to 3,870 μg/l for selenium(IV). Acute values in fish for selenium(IV) range from 620 μg/l for fathead minnow to 35,000 μg/l for carp. The final chronic value for selenium(IV) of 27 μg/l is based on sensitivities of rainbow trout. Based on data for three species, selenium(IV) was shown to be 5 to 32 times more toxic than selenium(VI). Although selenium(IV) appears to be more acutely and chronically toxic than selenium(VI) to most aquatic animals, this does not seem to be true for aquatic plants. Growth of several species of green algae were affected by concentrations ranging from 10 to 300 μg/l. BCFs that have been obtained for selenium (IV) with freshwater species range from 2 for the muscle of rainbow trout to 452 for the bluegill. Highest concentrations of selenium(IV) have been found in fish viscera, due to the uptake of selenium adhering to food.

Zinc

The levels of dietary zinc at which toxic effects are evident depend markedly on the concentration ratio of zinc to copper (Rand and Petrocelli 1985). Zinc is also a metabolic antagonist of cadmium, so that high zinc intakes in animals afford some protection against cadmium exposure. Acute toxicity values are available for 43 species of freshwater animals. Data indicate that acute toxicity generally decreases as hardness increases. When adjusted to a hardness of 50 mg/ℓ, sensitivities range from 50.70 μg/l for Ceriodaphnia reticulata to 88,960 μg/l for a damselfly. Additional data indicate that toxicity increases as temperature increases. Chronic toxicity data are available for nine freshwater species. Chronic values for two invertebrates range from 46.73 μg/l for Daphnia magna to >5,243 μg/l for the caddisfly, Clistoronia magnificia. Chronic values for seven fish species range from 36.41 μg/l for flagfish, Jordanella floridae, to 854.7 μg/l for the brook trout, Salvelinus fontinalis. The sensitivity range of freshwater plants is greater than that for animals. Growth of the alga, Selenastrum capriocornutum, is inhibited by 30 μg/l; however, 4-day EC50s (median effective concentration sufficient to produce some adverse response to 50% of test organisms) for several other species of green algae, exceed 200,000 μg/l. Zinc bioaccumulates in freshwater animal tissues at 51 to 1,130 times the water concentration.

9.1.2.2 Radionuclides

Basic ecological research on radionuclides in the environment has a 40-year history resulting in sophisticated models for identification and prediction of the movement and concentration of specific radionuclides. The same is true for effects on humans resulting from exposure to both external and internal sources of radiation. Most of the scientific literature concerning radioecology has resulted from interaction between DOE operated facilities and nearby universities.

The following discussion is a brief summary of the radionuclide literature reviewed. In general, transuranics tend to bind in the soils and sediments and have limited availability to biota. Bioaccumulation or concentration factors routinely are low between trophic levels. Data from Little et al. (1980) from the Rocky Flats Plant site indicate that radionuclide inventories (and thus radiation doses) in vertebrate populations are well below levels know to elicit effects.

The reported maximum surface water values for radionuclides do not exceed federal standards (Table 9-2), but do exceed some state standards for Woman Creek. Those radionuclides with maximum values exceeding state standards include gross alpha, gross beta, plutonium 239, tritium, and uranium (total) (Table 9-1). Elevated levels for some radionuclides are likely to exist in Woman Creek sediments (see Appendix D). At the reported surface water and sediment levels, it is not known whether sufficient sensitive methods exist to distinguish injury to biota due to radionculides from background "noise" (chance fluctuations due to climate, weather, human disturbance, etc., or injury from other contaminants) at the Rocky Flats Plant site. The following sections provide a summary of general information regarding the effects of radionuclide contamination on terrestrial and aquatic ecosystems.

Terrestrial Ecosystems

Historically, the principal reason for determining BCFs for terrestrial biota was to calculate the internal radiation dose to higher trophic levels at an equilibrium body burden from radionuclides assimilated from foodstuffs. For the most part, BCFs for mammals have been collected from fallout studies under widely varied habitat conditions (arctic, desert, temperature zone, and laboratory), and, consequently, there are few consistent generalizations. Concentration factors for cesium-137 typically show an increase from plants to mammalian herbivores as well as increases at the higher trophic levels. Ninefold increases in cesium-137 through the plant → mule deer → cougar food-chain were demonstrated in the work done by Pendleton et al. (1965). Also an increase of approximately 2- to 5- fold at each link in the lichen → caribou → wolf food-chain has been reported by Hanson et al. (1967).

Less comprehensive data are available for the other radionuclides, but it is evident that not all radionuclides are concentrated in food-chains and that different food-chains may exhibit markedly different concentration patterns for the same nuclide. The strontium-90 BCF for the plant → herbivore chain ranges from 0.02 to 8.4; while the BCFs for tritium, cobalt-60 and iodine-131 are less than 1.0, with the exception of 2.4 for seed → water → quail for cobalt-60 movement (Auerbach 1973).

There have been few field studies on the comparative uptake of actinides (transuranics) by biota from contaminated soils. Uranium, thorium, and plutonium transfer in terrestrial food-chains has not been well studied because of the difficulty and expense of analyzing these elements at low levels in biota and the frequent high degree of variation in field data that complicates statistical comparisons between different actinides. Field studies that have been conducted on soil-plant-animal transfer suggest that bioaccumulation of these elements does not occur. The Hakonson (1975) study of actinide levels in soils, plants, and animals indicates that, at the Trinity Site, residual plutonium was approximately 10 times lower in small rodents than in the corresponding grass samples. This same trend has been noted in other studies as well (Garten and Daklman 1978, Garten et al. 1981). Bly and Whicker (1978) found that the mean ratio of plutonium-239 in arthropods to plutonium-239 in 0 to 3 cm soil at Rocky Flats Plant was $1{:}9 \times 10^{-3}$.

Little et al. (1980) conducted a comprehensive study in the grassland ecosystem around Rocky Flats. The overall conclusions mirror the previously mentioned works in that plutonium was not accumulated up through the food-chain. Additionally, the body burdens of biota were significantly lower than required to elicit a biological or ecological effect.

Most studies of radiosensitivities of soil fungal populations have been performed in the laboratory. Studies on the effects of irradiation of natural populations in the field have been rare and have suffered from inadequate controls (Stotsky and Mortenson 1959, Stanovick et al. 1961)

A study by Edwards (1969), revealed distinct differences in radiosensitivities of various microarthropod groups, but all were killed at levels much lower than those lethal to microflora. Orbatid mites, the most radiation-resistant microarthropods, were killed by 200 kilorads. Auerbach et al. (1957) found that, with lower radiation doses, a lag effect exists in growth rates in certain microarthropods, such as Collembola. Cawse (1969) noted that bacteria are the most tolerant to radiation up to about 2.5 megarads. Fungi are resistant up to about 1 megarad (Johnson and Osborne 1964).

Fraley and Whicker (1973) found native shortgrass plains vegetation to be very resistant to chronic gamma radiation at exposure rates varying from 0.01 to 650 Roentgen/hour (R/hr usually expressed as roentgen equivalent man-rem). One of the most resistant species was Lepidium densiflorum, which became dominant at exposure rates of 12 to 28 R/hr and was able to germinate, develop, and complete seed set at exposure rates greater than 28 R/hr. The level of radiation exposure in their study is many orders of magnitude greater than any encountered in the environment around facilities such as Rocky Flats.

A long-term project was initiated in 1968 at Oak Ridge National Laboratory (Styron et al. 1975) to assess effects of mixed beta and gamma radiation from simulated fallout on a grassland ecosystem. Extensive statistical analyses of data on numbers of individuals collected for each of 76 arthropod and 2 molluscan taxa have identified no lasting significant changes in similarity or species diversity of experimental versus control communities as the result of the long-term irradiation at low doses rates. Natural fluctuations in community dynamics obscured any possible radiation effects.

Mammal species and populations exhibit a similar resistance to chronic low-level exposures and even acute exposures required in excess of 100 rads to elicit reproductive, hemopoietic, or survivorships responses (Kitchings 1978).

Aquatic Ecosystems

Aquatic food-chain dynamics are similar to those previously described for terrestrial ones. On the whole, the actinides have no known biological function and do not show an affinity for muscle in higher trophic level organisms (Poston and Klopfer 1988). In a study conducted at the Savannah River Plant by Whicker et al. (1990), aquatic macrophytes were found to have the highest concentration ratio, primarily, the authors suggest, due to adsorption of sediment particulates to surfaces. All other trophic levels were found to have very low concentration ratios. In nearly all cases, concentrations of transuranics in vertebrate tissues were very low. Because of low food-chain transfer factors for most uranics, low concentrations in water, sediments, macrophytes, and invertebrates generally result in low concentrations of transuranics in vertebrate tissues (Bair and Thompson 1974, Eyman and Trabalka 1980).

Only 5 to 10 percent of the plutonium and americium in sediments in a process waste pond on the Hanford Reservation were found to be available for foodweb transfer (Emery et al. 1975). The remaining fraction appeared to be tightly bound to particles and would be transported ecologically in particulate form. Watercress had a plutonium concentration about equal to that found in the sediments, while dragonfly larvae and snails had americium levels approximating levels in the sediments. All remaining biota had plutonium and americium concentrations which were generally well below those of the sediments. Goldfish in the pond concentrated small amounts of both isotopes.

With respect to the distribution of several long-lived radionuclides within aquatic ecosystems, the work of Whicker et al. (1990) tends to confirm and strengthen the concept that many radionuclides tend to reside entirely in the sediments. It appears that this is true for cesium-137 and the transuranium elements. The rule also seems to hold for different types of systems with widely varying limnological properties. As a consequence, only a very small fraction of the total system inventory can reside in the biotic components. For radionuclides that tend to sorb strongly to sediments, this distribution can probably be extended to most freshwater ecosystems.

9.1.2.3 Organic Compounds

Many of the organic compounds thought to be present at OU5 (Section 2.0) are on the RCRA Appendix VIII and IX Lists, the Superfund Target Compound List, and the EPA Clean Water Act Priority Pollutants Compounds List and are known to cause adverse acute and chronic effects on aquatic life, depending on their concentrations. A number of the organic chemicals detected in OU5 surface water have maximum values exceeding federal or state surface water standards (Tables 9-1 and 9-2). Those chemicals with maximum values exceeding federal standards include the pesticide parathion, and the volatiles, 1,2-dichloroethane, carbon tetrachloride, chloroform, tetrachloroethane, and trichloroethene. Organics detected in OU5 surface water for which there are no federal standards include the pesticide simazine, the semi-volatiles, 2-methylphenol and di-n-butylphthalate, and the volatiles, 2-butanone, acetone, carbon disulfide, and methylene chloride. The only organic contaminant with a maximum value exceeding CWA AWQC is the pesticide, parathion.

For the environmental evaluation, the organic chemicals of greatest concern are those which are readily accumulated by aquatic biota and are persistent in aqueous media. The pesticide, parathion, which was detected in OU5 surface water at a maximum concentration exceeding federal and state standards, is likely to be a contaminant of concern. The volatile organics, such as carbon tetrachloride and trichloethene, even though their maximum values exceed MCLs, are unlikely to be major contaminants of concern to biota given their tendency not to persist in aqueous media or be readily accumulated by biota. The development of criteria for selection of contaminants of concern will be made by the Risk Assessment Technical Working Group.

Chemicals lacking in federal or state water quality standards will also be evaluated for potential site-specific effects on biota. Locations of elevated levels of organic chemicals in groundwater may also warrant evaluation due to the potential interaction with surface water and subsequent potential for exposure to receptor organisms.

9.1.3 Protected Wildlife, Vegetation, and Habitats

9.1.3.1 Wildlife

The U.S. Fish & Wildlife Service has identified several listed endangered or threatened wildlife species which could possibly occur in the Rocky Flats Plant area. However, none is expected to occur because of lack of habitat. These species include the endangered bald eagle (Haliaeetus leucocephalus), the two threatened subspecies of peregrine falcon (Falco peregrinus tundris and F. p. anatum), the endangered whooping crane (Grus americana), and the endangered black-footed ferret (Mustela nigripes).

The bald eagle is primarily a winter resident around rivers and lakes, and the closest known nesting pairs are found at Barr Lake, 25 miles to the east of Rocky Flats. Although the Rocky Flats Plant Site lacks suitable bald eagle nesting habitat, bald eagles have been observed over the plant site, and one pair has been observed feeding regularly at Great Western Reservoir, located approximately 0.4 miles east of the site.

The whooping crane passes through Colorado during its spring and fall migrations. Whooping cranes blown off their migration course could use the Rocky Flats area as a night roost. These birds prefer large marshes and wetlands in broad open river bottoms and prairies. Such habitat is not present at Rocky Flats.

The two subspecies of peregrine falcon may occasionally occur in the Rocky Flats area as they hunt for prey. Nesting preferences are high cliff sides and river gorges, both of which are absent at Rocky Flats. However, nesting sites have been recorded to the west about 4 to 5 miles west of the site.

The historical geographic range of the black-footed ferret coincides with that of prairie dogs, a principal prey species. Although black-footed ferret populations are thought by many to be extinct in the wild, large prairie dog towns sufficient to support a black-footed ferret population (>80 acres for black-tailed prairie dogs), if found at Rocky Flats, would be surveyed by approved methods (U.S. Fish and Wildlife Service 1986).

Several additional species are of special interest to the State of Colorado because they are endangered in the state, are game species, have small and/or declining populations, or are pest/nuisance species (Colorado Division of Wildlife 1981, 1982a, 19826b, and 1985). These species will be identified and investigated during Task 2 and will be considered in the development of on-site food webs.

9.1.3.2 Vegetation

Thirteen federally-listed or -proposed plant species occur in Colorado, most of which are western slope species. One proposed endangered species, Ute ladies-tresses (Spiranthes diluvialis) is known to occur near Golden and could potentially occur at Rocky Flats, although it has not been found in previous botanical inventories. A number of candidate species for federal listing are known to occur in Jefferson and Boulder Counties, but have not been identified at Rocky Flats.

9.1.3.3 Wetlands

Numerous regulations and acts have been promulgated to protect water-related resources, including wetlands. Wetlands play an important role in ecosystem processing and in providing habitat to a variety of plant and animal species. An assessment of Rocky Flats wetlands was completed in 1989

(EG&G 1990g). Wetlands occur along Woman Creek, portions of the South Interceptor Ditch, and at Ponds C-1 and C-2. DOE activities with a potential to impact wetlands will follow regulations designed for their protection. Should filling of any wetlands occur, the U.S. Army Corps of Engineers would have jurisdiction.

9.2 ENVIRONMENTAL EVALUATION TASKS

An environmental evaluation at OU5 is necessary for Rocky Flats Plant to meet the requirements of Sections 121(b)(1) and (d) of CERCLA and Section 300.430(d) of the National Oil and Hazardous Substances Pollution Contingency Plan (55 FR 8666, 3/8/90). An environmental evaluation, in conjunction with the human health risk assessment, is required to ensure that remedial actions are protective of human health and the environment. Guidelines for conducting this evaluation, which is also called an ecological assessment, are provided by EPA in Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (U.S. EPA 1989c). Additional guidance is derived from EPA's Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document (U.S. EPA 1989d) and other guidance documents (Table 9-3).

The environmental evaluation is both a qualitative and quantitative appraisal of the actual or potential injury to biota other than humans and domesticated species due to contamination at OU5. The environmental evaluation is intended to reduce the inevitable uncertainty associated with understanding the environmental effects of contaminants present in OU5 and to give more definitive boundaries to that uncertainty during remediation.

The following plan for OU5 provides a framework for the review of existing data, the conduct of subsequent field investigations, and the preparation of the contamination assessment. Methodologies for the ecological and ecotoxicological field investigations (Tasks 3 and 9) are described in the Field Sampling Plan presented in Subsection 9.3. Several of the tasks presented in the following plan will require coordination between the various OUs. In order to assure an integrated effort and to provide a means for obtaining input from regulatory agencies throughout the preliminary planning and implementation tasks, a Risk Assessment Technical Working Group has been established. As participants in this group, representatives from EG&G, DOE, and each of the regulatory review agencies will be involved in activities such as the development of selection criteria for contaminants of concern, key receptor species, and reference areas, and decisions regarding the use of existing data.

TABLE 9-3

EXAMPLES OF EPA AND DOE GUIDANCE DOCUMENTS AND REFERENCES FOR CONDUCTING ENVIRONMENTAL EVALUATIONS

Barnthouse, L.W., G.W. Suter, S.M. Bartell, J.J. Beauchamp, R.H. Gardener, E. Linder, R.V. O'Neill and A.E. Rosen. 1986. User's Manual for Ecological Risk Assessment. Environmental Sciences Division. Publication No. 2679, ORNL-6251.

U.S. DOE. 1988a. Comprehensive Environmental Response, Compensation, and Liability Act Requirements. DOE Order 5400.YY. Draft, September 1988.

U.S. DOE. 1988b. Radiation Effluent Monitoring and Environmental Surveillance. DOE Order 5400.XY, Draft, September 1988.

U.S. DOE. 1990c. Radiation Protection of the Public and the Environment. DOE Order 5400.5

U.S. EPA. 1988a. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Interim Final. Office of Emergency and Remedial Response, Washington D.C., EPA/540/g-89/004.

U.S. EPA. 1988c. Superfund Exposure Assessment Manual. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/1-88/001.

U.S. EPA. 1988d. Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites. Office of Emergency and Remedial Response.. Washington, D.C. EPA/540/2-88/003.

U.S. EPA. 1989c. Risk Assessment Guidance for Superfund Volume II Environmental Evaluation Manual. Interim Final. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/1-89/001.

U.S. EPA. 1989d. Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document. Office of Research and Development. EPA/600/3-89/013.

U.S. EPA. 1989e. Exposure Factors Handbook. Office of Health and Environmental Assessment. Washington, D.C. EPA/600/8-89/043.

U.S. EPA. 1990. Guidance for Data Useability in Risk Assessment. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/G-90/008.9.2.1 Task 1: Preliminary Planning

9.2.1 Task 1: Preliminary Planning

This task includes a definition of the study area, a determination of the scope of the environmental evaluation, identification of DQOs, and development of a plan for obtaining consensus on selection criteria for contaminants of concern, key receptor species, reference areas, and the field sampling approach/design. The scope of the environmental evaluation will describe the kind and amount of information that will be collected in the study. The biological parameters that are to be measured, estimated, and calculated will be described. The time period and boundaries of the evaluation will be designated. Depending on the available pathways for exposure and the habitats potentially exposed to contamination, the study area for this ecological assessment may extend beyond the boundaries of each IHSS and Woman Creek.

9.2.1.1 Selection Criteria for Contaminants of Concern

Because not all contaminants found at OU5 will have adverse effects on biota, the list of chemicals to be evaluated can be narrowed. Chemical and species-specific criteria (e.g., likelihood of exposure) will be used for selecting those contaminants that are of particular concern from an ecological perspective at OU5. Chemical, physical and toxicological criteria will be used in selecting contaminants of concern. Selection of these specific criteria will be developed in consultation with EPA and the State. Examples of the potential criteria to be evaluated in selecting contaminants of concern are shown in Table 9-4.

Although the selection process for contaminants of concern parallels that for the Human Health Risk Assessment, the lists may differ somewhat based on contaminant fate and transport characteristics and species-specific toxicities. The process for selecting contaminants of concern is currently being developed by the Risk Assessment Technical Working Group. Selection of the contaminants of concern will be evaluated in accordance with EPA guidance (U.S. EPA 1989c). An appropriate scoring system may be used to quantify the selection as much as possible. The selection process for these criteria will take into account the limited data that are available to quantify some of these factors (e.g., concentrations detected on site; frequency of detection). In these cases, a weighting factor may be used to assign such criteria a low reliance. The screening values developed for each criteria will be used as tools to help select chemicals that need further assessment. They will not be used as limits which indicate absolute "no adverse effects" levels. Actual site-specific conditions will determine the potential for adverse effects in receptor species at OU5.

9.2.1.2 Identification of Key Receptors

Key receptors are those species or taxon which are or may be sensitive to the particular contaminants of concern. Organisms at each trophic level within a food web differ in their sensitivity and the ways they take in, accumulate, metabolize, distribute, and expel contaminants. The susceptibility of a

TABLE 9-4

POTENTIAL SELECTION CRITERIA FOR CONTAMINANTS OF CONCERN

Concentrations detected on site

Frequency of detection

Historical disposal information
- Type
- Quantity

Mobility in environmental media

Chemical fate (transport)
- Adsorption coefficient
- Partition coefficient (water-octanol)
- Water solubility
- Vapor pressure

Persistence
- Biodegradation
- Chemical degradation

Bioaccumulation potential

Bioavailability

Biotransformation potential

Background concentrations

Biochemistry
- Essential nutrient
- Enzyme inhibitor

Toxicity

Treatability

particular organism also varies with the mechanism through which contaminants are taken up from the environment. In general, the following criteria determine the susceptibility of the receptor to a particular contaminant (U.S. EPA 1989c):

- The rapidity with which the contaminant is absorbed from the environment
- Sensitivity of the receptor's tissues to the dosage incurred
- Relationship between tissue sensitivity and the expression of symptoms of toxic injury
- The rapidity of repair or accommodation to the toxic injury

Selection of key receptors will depend on the ability to detect toxic injury in the organism or subsequent adverse effects to the population. National standards on the definitions of injury to biological receptors are found in the Natural Resource Damage Assessment Rule [43 CFR Subtitle A Section 11.62 (f)]. These include death, disease, behavioral abnormalities, cancer, physiological malfunctions, and physical deformation. Additional methods for detecting injury to biological resources are provided in the Type B Technical Information Document: Injury to Fish and Wildlife Species (U.S. DOI 1987). The procedures described in these documents provide a framework for determining what categories of effects might be observed in the field during the site visit and subsequent surveys and for selecting appropriate study methods to establish relationships between contaminant distribution and concentration in the physical environment and biological consequences in the receptor organisms and populations (Reagan and Fordham 1991). By using this approach to focus efforts on examining specific effects in key receptor species, costs and sampling efforts will be reduced.

The selection of key receptors is in part a subjective decision based on species dominance or judged importance in the food chain. Selection criteria for key receptors will include consideration of the following:

- Sensitivity to contaminants
- Listing as rare, threatened, or endangered by a governmental organization
- Game species
- A key component of ecosystem structure and function (e.g., abundant prey for other important species)

Additional criteria used in the selection of key receptors include habitat preferences, food preferences, and other behavioral characteristics which can determine population size and distribution in an area or significantly affect the potential for exposure. Key receptors may include game species such as mule deer (Odocoileus hemionus) which is mobile and has a large home range; or an organism that is sedentary or has a more restricted movement, such as plants, some invertebrates, and some small vertebrates. For contaminants that bioaccumulate, the effects are usually most severe for organisms at the top of the food chain (e.g., top predators). Examination of contaminant effects on these more mobile species may necessitate the integration of data from different OUs.

A checklist of OU5 biota will be developed in conjunction with the ecological field inventory. The initial list of key receptors will be chosen from the checklist based on the selection criteria and will include organisms from each trophic level. The documented selection analysis will include an evaluation of the receptor's relation to potential contaminant exposure through both direct contaminant accumulation from the abiotic environment and bioaccumulation through the food chain. Examples of key receptors species (or taxon) likely to be on this list are presented in Table 9-5. This list will be refined as information is evaluated on known contaminant effects on these species (or similar species) and the documented levels of contamination present at the site.

Key receptors will be selected from this list for subsequent detailed food web analyses, and possible tissue sampling or other ecotoxicological analyses. Selection of key receptors for tissue analyses will depend on the receptor's suitability for sampling, sample size requirements, results of the preliminary exposure assessment, and expectation for finding contaminants in the tissues sampled (see Subsections 9.2.9 and 9.2.10). Final selection of the contaminants of concern and key receptors will provide the basis for the contamination assessment (Tasks 4 through 7). In the contamination assessment, food webs and contaminant exposure pathways will be developed for OU5. Information on these food webs will be used to relate quantitative data on contaminants in the abiotic environment to adverse effects in biota and to evaluate potential impacts to biota due to contaminant exposure.

9.2.1.3 Reference Areas

Determination of criteria for selection and sampling of reference areas will be coordinated between OUs and will be addressed by the Risk Assessment Technical Working Group. Reference areas will be identified as appropriate for terrestrial, wetland, and aquatic species and will be selected based on measurement endpoints. Reference areas are likely to be selected in the northwestern portion of Rocky Flats Plant away from potential effects associated with release from either Rocky Flats or OU5. Additional off-site areas may also be selected, as appropriate.

TABLE 9-5

POTENTIAL KEY BIOLOGICAL RECEPTORS FOR ASSESSMENT OF ECOLOGICAL IMPACTS AT OU5

Community	Taxon
Periphyton	Green algae Blue-green algae
Benthic Macroinvertebrates	Mayflies (larvae) Caddis flies (larvae) Chironomids (larvae) Crayfish
Fish	Fathead minnow Bluegill
Reptiles	Garter snake Bull snake
Mammals	Deer mouse Northern pocket gopher Microtines Rabbit Coyote
Birds	Mourning dove Mallard Killdeer Red-winged blackbird Ring-necked pheasant Cormorant Blue heron Great-horned owl
Terrestrial Invertebrates	Earthworms Grasshoppers
Grasses	Western wheatgrass Blue grama Cheatgrass
Shrubs/Forbs	Snowberry Willows Bindweed Sunflower Cattails Pondweed
Microbial Populations	Entire population

Reference areas need not be selected where current and historical data are available to assess impacts from OU5 contaminants. Where such data are not available, one or more reference areas may be selected based upon their similarity to OU5, their lack of exposure to contamination from Rocky Flats or other sources, and the selected measurement endpoint. If more than one habitat or ecosystem type (e.g., terrestrial and aquatic) is to be assessed at OU5, comparable reference areas may be established for each, or a reference area may be selected containing those habitats or ecosystem types in a comparable distribution. For OU5, at least one reference area may be located upstream of the assessment area unless conditions indicate the area is unsuitable as a reference area. Data collected at the reference area will be compared where possible to values reported in the scientific literature to demonstrate that the data represent a normal range of conditions. Methods used to collect data at the reference area will be comparable to those used at OU5.

The decision process for using reference areas in the investigation of adverse effects from contamination at Rocky Flats is presented in Figure 9-2. As shown in this figure, a number of activities will take place prior to the selection of reference areas. These activities include the determination that:

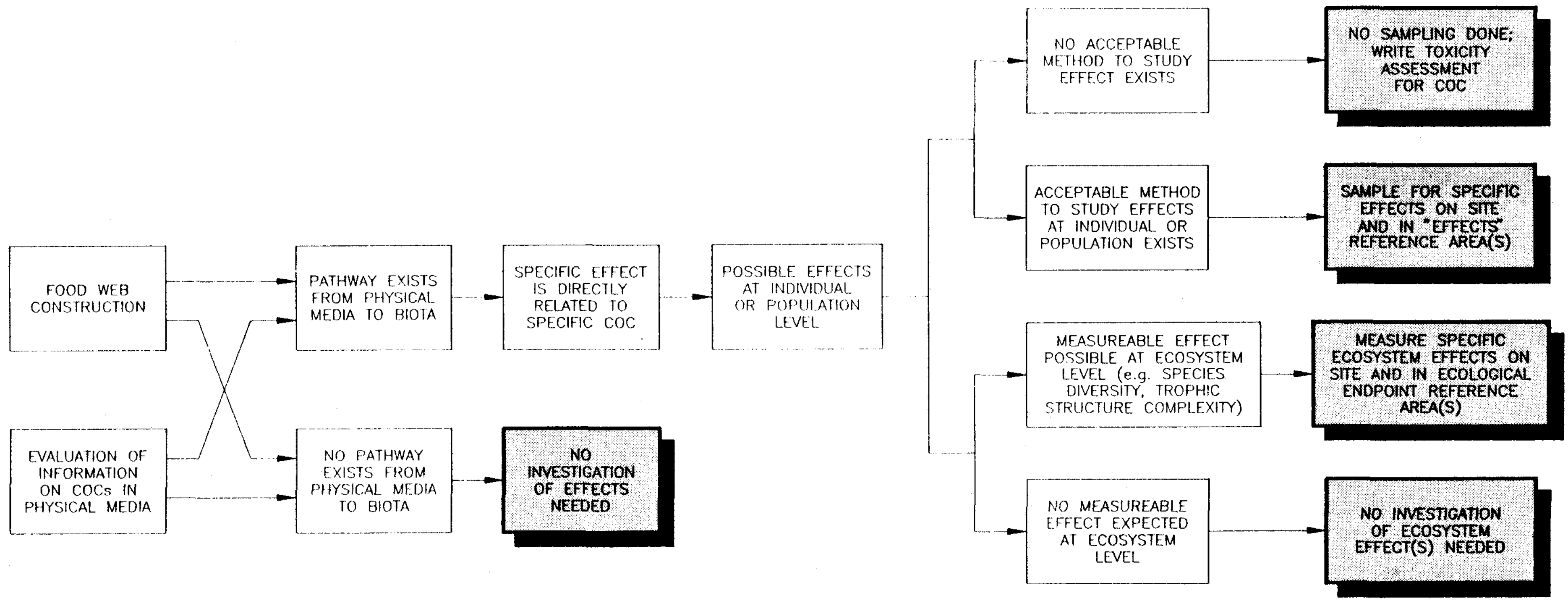
- A pathway (inhalation, ingestion, etc.) exists for the movement of a contaminant of concern from the physical abiota media to biota

- Acceptable methods are available to study the resultant effects of contamination at the individual, population, or ecosystem level (e.g., species diversity, trophic structure complexity)

Selection of a reference area(s) will ultimately depend on the specific effect or ecological endpoint that is to be measured. More than one reference area may be used depending on the effects to be studies. The selection of reference areas would be made to meet DQOs (U.S. EPA 1989c) and the selected assessment and measurement endpoints. Two basic criteria would be employed in the selection and establishment of reference areas:

1. The reference areas will be similar to OU5 in terms of soil series, topography, aspect, vegetation, habitat types and plant and animal assemblages.

2. The reference areas, including vegetation and wildlife, have not been impacted by releases from OU5 or other Rocky Flats Plant operable units.



U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5

PHASE I RFI/RI WORK PLAN

DECISION PROCESS FOR THE INVESTIGATION OF INDIVIDUAL, POPULATION, AND ECOSYSTEM LEVEL EFFECTS AND FOR THE USE OF REFERENCE AREAS FOR COC EFFECTS

FIGURE 9-2 MAY 1991

2506E003

9.2.1.4 Data Quality Objectives

The DQO development process will follow the three steps recommended by EPA (1989d). Step I of the DQO process involves preparing definitions and concise DQOs. Examples of Step I program DQOs for this environmental evaluation include the following:

- Identify appropriate site-specific receptor species, contaminants of concern, and exposure pathways to determine if there is a potential for adverse effects to occur as a result of contamination. This step includes determination of relevant contaminant concentrations in biological tissues.

- Evaluate the potential for impacts to occur to biological resources outside the boundaries of OU5 or the Rocky Flats Plant.

- Evaluate the need for remediation to protect the environment.

Steps II and III of the DQO process include identification of data uses and needs and design of the data collection program. Products of Step II include proposed statements of the type and quality of environmental data required to support the DQOs, along with other technical constraints on the data collection program. The objective of Step III is to develop data collection plans that will meet the criteria and constraints established in Steps I and II. Step III results in the specification of methods by which data of acceptable quality and quantity will be obtained. The DQO development process will continue as scoping of the environmental evaluation becomes more refined. Additional Step I decision-type DQOs may be needed or data collection-type DQOs may be modified based on Task 1 and Task 2 results and subsequent refinement of the field sampling plan.

9.2.1.5 Field Sampling Approach/Design

The Field Sampling Plan presented in Subsection 9.3 is designed to be flexible so that it can be revised as additional data are collected. Flexibility in the Field Sampling Plan will ensure that field data collection activities will be comparable to and compatible with previous data collection activities performed at the site while providing a mechanism for planning and approving new field activities. The Field Sampling Plan, in conjunction with the SOPs for Ecology (Volume V) will provide guidance for all field work by defining the sampling and data-gathering methods to be used on the project.

9.2.2 Task 2: Data Collection/Evaluation and Conceptual Model Development

As an integral part of the RFI/RI process, Task 2 of the environmental evaluation will focus on accumulating and analyzing pertinent information on three major areas:

- Species, populations, habitats, and food web interrelationships

- Types, distribution, and concentrations of contaminants in the abiotic environment (e.g., soil, surface water, groundwater, and air)

- Preliminary determination of potential exposure pathways and potential contaminant effects on OU5 biota based on literature review

The principal subtasks in Task 2 include Literature Review and Site Characterization. These subtasks will be performed in conjunction with Task 3, Ecological Field Investigation. Information that will be developed from these tasks includes the following:

- Chemical inventory/Contaminants of Concern - Existing information including that obtained on chemical contaminants from other investigations at Rocky Flats and other DOE facilities will be used in the development of a preliminary list of contaminants of concern.

- Initial toxicity test data - Preliminary data on the toxicity of potentially complex chemical mixtures in OU5 surface waters.

- Descriptive field surveys - Inventory of OU5 biota and locations of obvious zones of chemical contamination, ecological effects, and human disturbance.

- Species inventory - Plant and animal species known to occur within OU5 or to potentially contact contaminants at OU5 and their trophic relationships.

- Population characteristics - Information on the abundance of key species (see SOPs).

- Food habit studies - Available information from literature sources to supplement field observations and possible gut content analysis on key receptor species.

9.2.2.1 Literature Review

As an essential part of Task 2, a review of available documents, aerial photographs, and data relevant to the site will be completed. This will allow compilation of a database from which to determine data gaps and to provide evidence for a defensible field sampling program. Prior studies by DOE and the Rocky Flats Plant operating contractors will be reviewed and evaluated. Information to be reviewed will include the following:

- Project files maintained by Rockwell International and EG&G

- Project reports and documents on file at the Front Range Community College Library, at the Colorado Department of Health, and at the Colorado Division of Wildlife

- DOE documents and DOE orders

- The Phase I database

- The Rocky Flats EIS database

- Data from ongoing environmental monitoring and National Pollution Discharge Elimination System (NPDES) programs

- Studies conducted at Rocky Flats on radionuclide uptake, retention, and effects on plant and animal populations

- Scientific literature, including ecological and risk assessment reports, from other DOE facilities (Oak Ridge National Laboratory, Los Alamos, Hanford, Savannah River, Fernald)

If available and applicable, historical data will be used. Where the same methods are not used in the collection of new data, use of historical data will depend on the demonstrated comparability of the data collection methods. Where possible, analytical data files will be made available in an electronic file format.

9.2.2.2 Site Characterization

Environmental resources at the site will be characterized based on reviews of existing literature and reports, including results from the Phase I RFI/RI investigation, other operable unit RFI/RI investigations and the Task 3 ecological field investigation. The description of the site will be presented in terms of the following distinct resource areas:

- Meteorology/air quality
- Soils
- Sediments
- Geology
- Surface and groundwater hydrology
- Terrestrial ecology

- Aquatic ecology
- Protected/important species and habitats

The purpose of the site characterization is to describe resource conditions as they exist without remediation. The narrative with supporting data will include descriptions of each resource, with attendant tables and figures, as appropriate, to depict, in a concise and clear fashion, site conditions, particularly as they influence contaminant fate and transport.

Included in this task is the development of a community food web model (Reagan and Fordham 1991) to describe the feeding relationships of organisms at Rocky Flats Plant. Food web construction begins with gathering information to evaluate the food habits of species or species groups (e.g., grasshoppers) found or potentially occurring on site. Standard computer searches will be augmented with searches of local university libraries to locate any regionally pertinent studies on food habits. The preliminary list of important species, compiled from background information, will be completed based on observations of presence and abundance made during the ecological site surveys and on trophic level data obtained from the food web model. Based on the model, a modified list of species will be made using toxicological information (toxicity assessment) to determine which species or species groups might be most affected or most sensitive to the chemical(s) of interest.

Data from past studies and preliminary data from current environmental studies will be used to better define the present distribution of contaminants in the abiotic environment and to develop an initial food web model. The food web model in conjunction with a preliminary pathways analysis will identify likely or presumed exposure pathways or combinations of pathways and receptor species at risk. Based on this preliminary information, the Task 3 and Task 9 field investigation sampling approach/designs may be revised.

9.2.3 Task 3: Ecological Field Investigation

The Phase I field investigation for OU5 consists of the following separate programs: (1) the air quality program which will entail emissions estimation and modeling; (2) the soils, surface water, and groundwater sampling programs, which will be conducted as part of the Phase I RFI/RI activities; and (3) the terrestrial and aquatic biota sampling program, which will be conducted as part of this environmental evaluation.

9.2.3.1 Air Quality

A site-wide air quality monitoring program is currently being conducted at Rocky Flats. Specific air monitoring is also being done at OU5. These data can be used to model airborne deposition and transport of contaminants through the food web to potential receptors. Such modeling could be performed where data in abiotic media are inadequate. Where the inhalation pathway is considered to be significant in the case of OU5 biota, a detailed pathways analysis and assessment of potential adverse effects using these transport model data will be performed.

9.2.3.2 Soils

Few data exist on contaminants present in surficial materials at OU5. Groundwater monitoring wells have been installed at several locations within the drainages, but all wells are outside OU5 IHSS boundaries. Soil samples from various depths in these wells were analyzed. These data have not been validated, and there is some uncertainty in the unvalidated data.

The purpose of the Phase I RFI/RI sampling and analysis program is to provide data for characterizing the IHSSs and for confirming the presence or absence of contamination. The Phase I RFI/RI Work Plan proposes to collect soil samples from each of the IHSSs at OU5. Surficial soil samples will be collected in the Ash Pits, the Original Landfill, and the Surface Disturbances areas. Surface soils samples will be analyzed for radionuclides and metals in the Ash Pits and proximal to the Original Landfill, and additionally for organics in the Surface Disturbance Areas. Soil samples will be collected from IHSS 115, Original Landfill, only where there are areas of anomalous radiation readings or high soil gas readings. The list of soil analysis parameters is presented in Table 7-6, and the planned analytical program is presented in Table 7-7. In addition to these analyses, soil analyses will be conducted in the field and laboratory to confirm and clarify Soil Conservation Service descriptions and classifications. This information will be used to evaluate suitability of the soils for plant growth and to assist in the selection of suitable reference areas.

Surficial soil samples will be of prime importance for determining source contaminants for biota. This uppermost layer provides the major source of nutrients and contaminant uptake for the vegetation under study and is also a source of potential contaminant ingestion to wildlife. Soil samples from all depths are related to surface water and groundwater regimes. Fluids moving through the soils can leach contaminants, transport them through available flow paths, and deposit them in downgradient environments. Contamination in soil and groundwater at a depth of greater than 20 feet (maximum depth of burrowing animals and plant root penetration) will not be considered to affect biota.

The sampling and analysis programs under the Phase I RFI/RI field investigations have been reviewed and modified as necessary to ensure that sampling intervals, methods, and analytical program are appropriate and meet the DQOs of the environmental evaluation. Data from the Phase III OU1 RFI/RI program and the Phase II OU2 RFI/RI Program will also be evaluated for use in characterizing the nature and areal extent of surface soil contamination in the vicinity of OU5. The information will be used to help identify exposure pathways for the environmental assessment.

9.2.3.3 Surface Water and Sediments

Surface water and sediment samples are collected on a regular basis as part of ongoing investigations at OU5 as well as nearby OUs 1 and 2. These investigations will continue. This Phase I RFI/RI Work Plan proposes extensive sampling along Woman Creek, the South Interceptor Ditch, and in Ponds C-1 and C-2. In addition, samples will be collected upstream of the Rocky Flats Plant to provide background data. Samples will be analyzed for metals, radionuclides, inorganics, and organics. Total organic carbon in soils and sediments and sediment grain size will also be determined as part of the analytical program.

Surface water sampling and analytical results presented in the Final OU1 RFI/RI Work Plan and the Draft Final OU2 RFI/RI Work Plan will be evaluated with respect to the abiotic sampling programs planned in these OUs to assure abiotic data needs for the environmental evaluations at each of these OUs are addressed. Sampling locations and programs presented in each of these work plans will be integrated. Chemical results from the OU1 and OU2 surface sampling locations will be reviewed and incorporated into the OU5 environmental evaluation as needed.

9.2.3.4 Groundwater

Groundwater monitoring wells upgradient and downgradient of some of the IHSSs provide limited information on groundwater conditions in Woman Creek Drainage. This Phase I RFI/RI proposes to install monitoring wells downgradient of the Original Landfill, Ash Pits, and Ponds C-1 and C-2. The laboratory analytical results will be used to assess the presence or absence of groundwater contamination and to assess the exposure pathway, if present.

Data from the Phase III OU1 RFI/RI Program and the Phase II OU2 RFI/RI Program will also aid in characterizing the nature and areal extent of groundwater contamination in the vicinity of the site. The hydrogeologic information and laboratory analytical results from these planned boring and well installation programs will likewise be incorporated in this environmental evaluation where applicable. The information will be used to assist in determining the nature and extent of contamination in shallow groundwater and help identify exposure pathways for the environmental assessment.

9.2.3.5 Terrestrial and Aquatic Biota

Terrestrial and aquatic species in the Rocky Flats Plant area have been described by several researchers (Weber et al. 1974; Clark 1977; Clark et al. 1980; Quick 1964; Winsor 1975; CDOW 1981; CDOW 1982a, 1982b); most of these reports are summarized in the Final EIS (U.S. DOE 1980). In addition, terrestrial and aquatic radioecology studies conducted by Colorado State University (CSU) and DOE (Rockwell International 1986; Paine 1980; Johnson et al. 1974; Little 1976; Hiatt 1977), along with annual monitoring programs at Rocky Flats Plant, have provided information on the plants and animals in the area and their relative distribution.

Limited field surveys will be conducted in Task 3 to characterize current biological site conditions in terms of species presence, habitat characteristics and/or community organization. The emphasis will be to describe the structure of the biological communities at OU5 in order to identify potential contaminant pathways, biotic receptors, and key species.

Initial aquatic toxicity tests using Ceriodaphnia spp. and fathead minnows will be conducted at OU5 under Task 3. The technical objective of the toxicity tests is to provide a screening mechanism to aid in the determination of the nature and extent of contamination, particularly since there is the potential for exposure to mixtures of contaminants. EPA recognizes the usefulness of such toxicity testing as a means for integrating the effects of all toxic pollutants, which cannot be measured by chemical analysis. Standardized EPA acute and chronic test methods will be followed in accordance with NPDES toxicity testing procedures currently being used at Rocky Flats.

Vegetation

The objectives of the vegetation sampling program are to provide data for: (1) the description of site vegetation characteristics; (2) identification of potential exposure pathways from contaminant releases to higher trophic-level receptors; (3) selection of key species for contaminant analysis to determine background conditions for OU5; and (4) identification of any protected vegetation species or habitats.

A number of habitat types are expected to be found in the Woman Creek Drainage (Clark et al. 1980). Grasses characteristic of the short grass plains are expected to be abundant. Representative species include blue grama (Bouteloua gracilis), Junegrass (Koeleria cristata), dropseed (Sporobolus spp.), slender wheatgrass (Agropyron trachycaulum), and green needlegrass (Stipa viridula), which are interspersed with other grasses, shrubs, and a variety of annual flowering plants. Transects will be established at each of the IHSSs, along the South Interceptor Ditch, and along Woman Creek Drainage to collect phytosociological data on biomass and cover, shrub/tree density and frequency, and species presence.

Wetland Vegetation

Wetlands have been identified along Woman Creek and the South Interceptor Ditch (EG&G 1990g). These occur as linear wetlands that support hydrophytic vegetation species including sandbar willow (Salix exigua), american watercress (Barbarea orthoceras), and plains cottonwood (Populus sargentii). Other species associated with these wetlands include broad-leaf cattail (Typha latifolia), baltic rush (Juncus articus), cordgrass (Spartina pectinata), silver sedge (Carex praegracilis), and various bulrushes

(Scirpus spp.). Transects will be established in adjacent wetland vegetation habitats at the designated aquatic sampling locations along the South Interceptor Ditch and Woman Creek and around Ponds C-1 and C-2 to collect phytosociological data on biomass and cover, shrub/tree density and frequency, and species presence.

Periphyton

The periphyton community is a closely-adhering group of organisms that form mat-like communities on rocks, other solid objects, or the stream bottom. The community is composed of algae, bacteria, fungi, detritus, and other macroscopic heterotrophic organisms. Because of the large surface-to-volume ratio of its constituents, periphyton have been found to be an excellent indicator community for accumulation of contaminants. Periphyton samples will be collected at designated locations (see Section 9.3.2.2) on the South Interceptor Ditch, along Woman Creek, and at Ponds C-1 and C-2.

Periphyton communities provide a sensitive mechanism to detect changes in aquatic environments that result from the introduction of contaminants. Taxonomic composition and relative abundance of periphyton can be measured on natural substrates as well as standardized artificial substrates. On hard artificial substrates, data on algal abundance, biomass, and species composition will be obtained by removing the substrate and by scraping or brushing the organisms from a measured area into a container.

Benthic Macroinvertebrates

Benthic macroinvertebrates may exist in rocky/gravelly substrates or as soft bottom communities along portions of Woman Creek, the South Interceptor Ditch, and Ponds C-1 and C-2. The soft-bottom benthos are those macroscopic invertebrates inhabiting mud or silt substrates, whereas the immature stages of insects inhabit rock surfaces, rooted stems, and leaves or gravelly substrates. Because these communities are essentially stationary, they are good indicators of past and present habitat contamination. Additionally, their feeding methods (filtering microscopic organisms and fine materials, preying on smaller invertebrates, and grazing on periphyton), suggest that benthic species are ingesting other organisms that are potentially concentrating contaminants. Designated locations in the South Interceptor Ditch, Woman Creek, and Ponds C-1 and C-2 (see Section 9.3.2.2) will be sampled for benthic organisms.

Fish

Fish can be important components of ecological assessments because they are relatively long-lived, occupy upper trophic levels of aquatic ecosystems, and they may spend their entire lives in relatively small areas. Fish species representing both herbivores and carnivores are likely present in OU5 aquatic habitats and may demonstrate biomagnification of contaminants within the pond or creek ecosystem. Designated aquatic sampling locations (see Section 9.3.2.2) will be sampled for fish where the habitat is appropriate.

Terrestrial Wildlife

A field survey will be conducted to gather data on animal communities at Woman Creek Drainage. The objective of the animal life survey is to: (1) describe the existing animal community at Woman Creek Drainage; (2) identify potential contaminant pathways through trophic levels; (3) develop food web models including contribution from vegetation; (4) identify key species for potential collection and tissue analysis; and (5) identify any protected species.

The field survey as presented in the Field Sampling Plan (see Section 9.3) will document the presence of terrestrial species and allow for a general description of the community. Some species (e.g., songbirds, larger mammals, reptiles, and raptors) may use the area daily, seasonally or sporadically, or wander through as vagrants. Survey timing and techniques will consider these uses.

9.2.4 Contamination Assessment (Tasks 4 through 7)

The contamination assessment includes Tasks 4 through 7. The two major objectives of the contamination assessment are to:

- Obtain quantitative information on the types, concentrations, and distribution of contaminants in selected species, and

- Evaluate the effects of contamination in the abiotic environment on ecological systems.

Conducting a contamination assessment requires an evaluation of chemical and radiological exposures and the subsequent toxicological effects on key species. Of specific importance in the contamination assessment is the identification of exposure points, the measurement of contaminant concentrations at those points, and the determination of potential impacts or injury. Impacts may result from movement of contaminants through ecological systems or from direct exposure (inhalation, ingestion, or deposition).

The Contamination Assessment for OU5 will be based on existing environmental criteria, published toxicological literature, and existing, site-specific environmental evaluations. The program design will be integrated with other ongoing RFI/RI studies so that concentrations of contaminants in abiotic media can be related to contaminant levels and effects in biota. A preliminary contamination assessment will be made in Task 2 based on the site characterization and contaminant identification activities. The preliminary Task 2 assessment will be used to revise the Task 9 ecotoxicological field investigation sampling design. The contamination assessment process described in the following tasks will include the development of a site-specific pathways model to quantify the potential for contaminant exposure and adverse effects in biota.

The objectives and description of work for each of the contamination assessment tasks is described below.

9.2.5 Task 4: Toxicity Assessment

This assessment will include a summary of the types of adverse effects on biota associated with exposure to site-related chemicals, relationships between magnitude of exposures and adverse effects, and related uncertainties for contaminant toxicity, particularly with respect to wildlife. Ecological receptor health effects will be characterized using EPA-derived critical toxicity values when available in addition to selected literature pertaining to site- and receptor-specific parameters.

The toxicity assessment will provide brief toxicological profiles centered on health effects information on wildlife populations. The profiles will cover the major health effects information available for each contaminant of concern. Data pertaining to wildlife species will be emphasized, and information on domestic or laboratory animals will be used when wildlife data are unavailable. Adequacy of the existing database will be evaluated as part of this task.

9.2.6 Task 5: Exposure Assessment and Pathways Model

This task will identify the exposure or migration pathways of the contaminants, taking into account environmental fate and transport through both physical and biological means. Each pathway will be described in terms of the chemical(s) and media involved and the potential ecological receptors. The exposure assessment process will include the following three subtasks:

- Identify exposure pathways
- Determine exposure points and concentrations
- Estimate chemical intake for receptors

Each of these subtasks is described below.

9.2.6.1 Exposure Pathways

The purpose of this subtask is to qualitatively identify the actual or potential pathways by which various biological receptors at or near OU5 might be exposed to site-related chemicals or radionuclides. The exposure pathway analysis will address the following four elements:

- A chemical/ radionuclide source and mechanism of release to the environment
- An environmental transport medium (e.g., soil, water, air) for the released chemical/ radionuclide
- A point of potential biological contact with the contaminated medium
- A biological uptake mechanism at the point of exposure

All four elements must be present for an exposure pathway to be complete and for exposure to occur. Exposure pathways will be evaluated and modeled, where possible, using the pathways approach (Reagan and Fordham 1991; Thomann 1981).

The pathways approach uses a bioaccumulation model of contaminant transfer through a food web. The model links contamination in soil and water to contamination in biota. The pathways model approach blends standard environmental assessment methods with ecological and toxicological modeling to produce an integrated procedure to selecting indicator species and conducting an investigation of ecosystem effects resulting from contamination in soil and water. Where possible, uncertainty in the model is reduced by direct sampling (i.e., tissue analysis).

Toxicity tests, such as those proposed for Task 3, can also be used to conduct a direct effects-related investigation. Additional toxicity tests may be designed based on the pathways model results.

9.2.6.2 Determination of Exposure Points and Concentrations

The identified exposure points are those locations where key ecological receptor species may contact the contaminants of concern. Potential for exposure depends on characteristics of the contaminant, the organism, and the environment. Determination of exposure points entails an analysis of key receptor species, locations, and food habits in relation to potential contaminant exposure both through direct contaminant accumulation or deposition from the abiotic environment and through indirect bioaccumulation. The exposure assessment for OU5 will provide information on the following:

- What organisms are actually or potentially exposed to contaminants from OU5
- What the significant routes of exposure are
- What amounts of each contaminant organisms are actually or potentially exposed to
- Duration of exposure
- Frequency of exposure
- Seasonal and climatic variations in conditions which are likely to affect exposure
- Site-specific geophysical, physical, and chemical conditions affecting exposure

A determination of the nature and extent of contamination in the abiotic media (air, soils, surface water, and groundwater) is presented in this Phase I RFI/RI Work Plan for Woman Creek Drainage. Phase I data, where available and validated, will be summarized and used to characterize source areas and release characteristics at the site. The exact exposure points can be expected to vary depending on both the contaminant and the key receptor species under consideration.

Concentrations of chemicals that are likely to have the greatest impact (based on concentration in the environment, toxicity values, and biological uptake) will be determined by actual environmental media sampling for each exposure point or by environmental fate and transport modeling. Fate, transport, and endpoint contamination levels in abiotic media may be modeled, where necessary, using environmental multi-media risk assessment models. Such models can provide the potential maximum concentrations of chemicals at the exposure points by which to evaluate the "worst-case" scenario.

9.2.6.3 Estimation of Chemical Intake by Key Receptor Species

This step includes an evaluation of key receptor species' contaminant uptake by direct routes (i.e., inhalation, ingestion, dermal contact) and indirect routes (bioconcentration, bioaccumulation, biomagnification). The amounts of chemical and radiological uptake will be estimated using appropriate conservative assumptions, site-specific analytical data on contaminant concentrations in abiotic and biotic media, and forthcoming guidance from EPA's Wildlife Exposure Factors Handbook (to be published in 1991). The pathways analysis model (Reagan and Fordham 1991; Thomann 1981) will be used to establish relationships between concentrations of a chemical in different media with concentrations known to cause adverse effects.

Direct measurement of contaminant uptake through tissue analyses will be conducted during Task 9 of the environmental evaluation. Such site-specific data and field observations will be used to reduce uncertainty in the pathways model and strengthen interpretation of the overall study.

9.2.7 Task 6: Contamination Characterization

Contamination characterization entails the integration of abiotic exposure concentrations and reasonable worst-case assumptions with the information developed during the exposure and toxicity assessments to characterize current and potential adverse biological effects (e.g., death, diminished reproductive success, reduced population levels, etc.) posed by OU5 contamination. The potential impacts from all exposure routes (inhalation, ingestion, and dermal contact) and all media (air, soil, groundwater, and surface water/ sediment) will be included in this evaluation as appropriate according to EPA guidance (U.S. EPA 1989c).

Characterization of adverse effects on receptor species and their populations is generally more qualitative in nature than characterizing human risks. This is because the toxicological effects of most chemicals have not been well documented for most species. Criteria or toxicological benchmarks that are usable and applicable for the evaluation of ecological effects are generally limited. EPA AWQC and Maximum Allowable Tissue Concentrations (MATC) are the most readily available criteria. Criteria found in federal and Colorado state laws and regulations pertaining to the preservation and protection of natural resources can also be used. Criteria may also be derived from information developed for use under other environmental statutes, such as the Toxic Substances Control Act or the Federal Insecticide, Fungicide and Rodenticide Act. An attempt will be made to consider the adverse effects of chemicals on populations and habitats rather than on individual members of a species according to EPA guidance (1989c, 1989d). Where specific information is available in the published literature, a more quantitative evaluation of effects will be made using the site-specific pathways model. This approach is in agreement with EPA guidance (U.S. EPA 1989c).

9.2.8 Task 7: Uncertainty Analysis

The process of assessing ecological effects is one of estimation under conditions of uncertainty. Understanding the effects of environmental stresses resulting from contamination on real populations depends on complex abiotic and biotic processes that cannot be reproduced in the laboratory. To address uncertainties, the OU5 environmental evaluation will present each conclusion, along with the issues that support and fail to support the conclusion, and the uncertainty accompanying the conclusion. Factors that limit or prevent development of definitive conclusions will also be discussed. In summarizing the assessment data, the following sources of uncertainty and limitations will be specified:

- Variance estimates for all statistics
- Assumptions and the range of conditions underlying use of statistics and models
- Narrative explanations of other sources of potential error

Validation and calibration of the pathways model will also be used where practicable.

9.2.9 Task 8: Planning

Task 8 will include planning for tissue analysis studies and any additional ecotoxicological studies (e.g., reproductive success, enzyme analyses, microbial respiration) needed to assess adverse effects from the contaminants of concern on key receptors. Initial designing for the Task 9 ecotoxicological field investigations will begin after contaminants of concern and key receptors have been selected in Task 2. Species to be sampled for tissue analyses will be designated to the earliest extent possible in order to avoid a duplication of the Task 3 sampling effort.

The need for measuring additional ecotoxicological endpoints in Task 9 will be evaluated based on the pathways analyses and published information on direct toxic effects. Selection of field methodologies will be based on a review of available scientific literature providing quantitative data for the species of concern or similar test species. Analysis of population, habitat, or ecosystem changes will be based on species or habitats that represent broad components of the ecosystem or are especially sensitive to the contaminants. In order to select methodologies for the ecotoxicological field sampling program, the biological response under consideration and the proposed methodology should satisfy program DQOs as well as the following more specific criteria:

- The biological response is a well-defined, easily identifiable, and documented response to the designated contaminant(s) of concern (i.e., methodology and measurement endpoint are appropriate to the exposure pathway).

- Exposure to the contaminant is known to cause the biological response in laboratory experiments or experiments with free-ranging organisms.

- Methodology is capable of demonstrating a measurable biological response distinguishable from other environmental factors such as weather or physical site disturbance.

- The biological response can be measured using a published standardized laboratory or field testing methodology.

- The biological response measurement is practical to perform and produces scientifically valid results (e.g., sample size is large enough to have useful power and small Type I error).

Tissue studies to document site-specific contamination will be conducted in Task 9 for both aquatic and terrestrial systems. Tissue analyses will be conducted on selected species from OU5 and reference areas (if necessary) to document current levels of specific target analytes. Information from the Task 2 data evaluation and Task 3 field survey will determine the species and contaminants to be tested and the methods to be used. Selection of the target analytes, species, and tissues will depend on an initial determination as to which contaminants are likely to adversely impact biota and which contaminants are likely to be present in concentrations sufficient for detection.

Acute and chronic aquatic toxicity tests using fathead minnows and Ceriodaphnia spp. are proposed for Task 3 (see Subsection 9.3.5). These simple screening tests will provide an initial determination of the toxicity of potentially complex chemical mixtures in Woman Creek, the South Interceptor Ditch, and Ponds C-1 and C-2. If toxicity is observed in either the acute or chronic tests at any one station, then a supplemental toxicity testing program in conjunction with physical and chemical analyses of the water and sediment may be designed for that location to determine the potential extent of the toxicant(s).

Toxicity testing methods are available for terrestrial ecosystems using microbes, earthworms, crickets, and grasshoppers (U.S. EPA 1989c). The need for such tests will be evaluated based on the above criteria as part of this planning process.

Prior to conducting Task 9 studies, the field sampling plan will be refined to address the proposed methodologies. More specific DQOs will be formulated based on the proposed methodologies and will address the following:

- The number and types of analyses to be run
- The species, locations, and tissues to be sampled
- The number of samples to be taken
- The detection limits for contaminants
- The acceptable margin of error in analyzing results

9.2.10 Task 9: Ecotoxicological Field Investigations

Tissue analyses will comprise most of the Task 9 ecotoxicological field investigation. Because individuals and species accumulate contaminants differentially in their tissues depending on the exposure route and form of the contaminants, environmental concentrations and general uptake rates will not necessarily predict biotic concentrations or adverse effects. Tissue analyses will be conducted to measure the total concentration of specific chemical compounds in key receptor species. By comparing tissue analysis results to toxicological benchmark concentrations (e.g., LC50 or MATC values), the potential for adverse effects in a population can be characterized. Analysis of tissue contaminant concentrations will provide data to confirm the predicted relationship, if any, between environmental concentrations and the amount of contaminants accumulated in receptor species.

Selection of the species and specific tissues for analysis will be based on a preliminary evaluation of site-specific food webs, potential contaminant transport pathways, and potential for bioaccumulation, bioconcentration, and biomagnification. The decision process for conducting tissue analyses is presented in Figure 9-3. Tissue sampling will only be conducted for those contaminants of concern which bioaccumulate in tissue. Whole bodies or specific tissues will be analyzed depending on which portion is consumed by higher trophic level organisms. Suitability of the species for sampling and sampling size requirements will largely determine the species to be selected for tissue analysis.

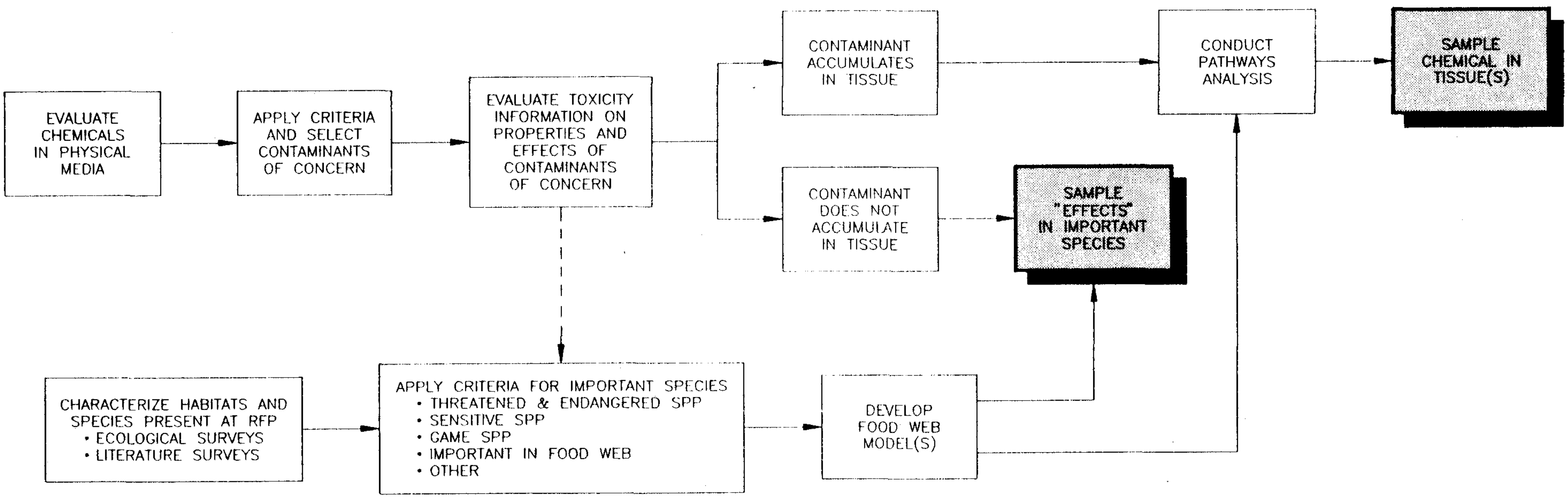
To the extent possible, tissue samples will be collected simultaneously with environmental media samples (see Section 7.0). This will allow for a determination of site-specific BCFs. These BCFs will be incorporated into the final exposure assessment and will be used to calibrate/validate the pathways model. Where BCFs cannot be determined, published or predicted BCF values will be used in the pathways model to assess potential impacts.

For contaminants of concern which bioaccumulate, the acceptable concentration (i.e., ARAR/TBC) in the physical environment (e.g., water) may be below reliable detection limits measurable by direct methods (see Tables 3-1 through 3-3). For example, the freshwater chronic AWQC for protection of aquatic life for DDT is 0.001 μg/l, while the detection level using gas chromatography is 0.1 μg/l. In these instances, indicator species would be sampled as indirect indicators of contaminant concentrations in the physical media that bioaccumulate.

Where ARARs/TBCs (i.e., acceptable levels in receptor species or next lowest prey species) are established, tissue sampling need only be conducted on site and not in the reference areas. Where no applicable criteria exist, sampling for contaminants of concern would be conducted both on site and in appropriate reference area(s). The decision process on the use of reference areas for sampling contaminants in tissues is shown in Figure 9-4.

Statistical tests will be used in the measurement of the contaminant-specific biological response in samples from OU5 and the reference areas. Use of statistical tests will be consistent with DQOs and quality assurance provisions of the Quality Assurance Project Plan (QAPjP).

Additional ecotoxicological studies or toxicity tests may include in-situ (in-field) and/or laboratory toxicity tests. In-situ methods usually involve exposing animals in the field to existing aquatic or soil conditions. Laboratory toxicity tests can be used to evaluate the lethal or sublethal effects of chemicals as they occur in environmental media. Both approaches can be used to test for toxicity of mixtures as they actually occur in the environment. Selection of a particular methodology is generally based on the



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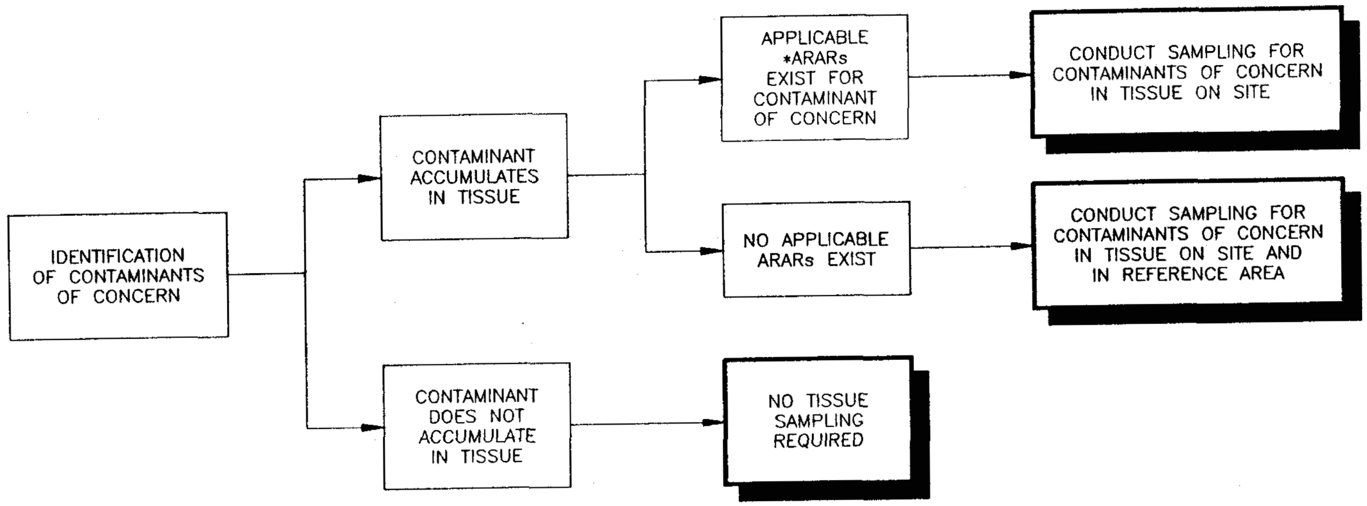
DECISION PROCESS FOR CHEMICAL SAMPLING OF TISSUES

FIGURE 9-3 MAY 1991

2506E001



* ARARs MAY NOT BE APPLICABLE IF THEY ARE BASED ON SPECIES THAT DO NOT EXIST ON SITE (e.g., *TROUT*) OR IF THEY ARE BASED ON BIOTA PATHWAYS TO HUMANS.

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DECISION PROCESS ON USE OF REFERENCE AREAS FOR CONTAMINANTS IN TISSUES

FIGURE 9-4 MAY 1991

2506E002

capability of the method to demonstrate a measurable biological response to the selected contaminant(s) of concern in addition to those specific criteria presented in Subsection 9.2.9.

9.2.11 Task 10: Environmental Evaluation Report

Task 10 will include the summary of information and production of an Environmental Evaluation Report as part of the RFI/FI Report. The Environmental Evaluation Report will be prepared in a clear and concise manner to present study results and interpretation. Relevant data from the environmental evaluation, in addition to relevant Phase I RFI/RI data, will be integrated and evaluated in the characterization of potential environmental impacts. The following topics will be covered in the report:

- Objectives
- Scope of Investigation
- Site Description
- Contaminants of Concern and Key Receptor Species
- Contaminant Sources and Releases
- Exposure Characterization
- Contamination (Impact) Characterization
- Remediation Criteria
- Conclusions and Limitations

A proposed, detailed outline of the report is shown in following Table 9-6.

Remediation Criteria

The primary element used in the assessment of environmental effects or risk is a set of environmental criteria to which measured and or predicted concentrations of hazardous constituents in abiotic media are compared. Where these criteria are exceeded, adverse effects are likely to occur. Where water quality or other available federal or state criteria are available for comparison to concentrations of contaminants, they are generally used (see Section 9.2.7) (U.S. EPA 1989c). Remediation criteria can also be developed from other environmental statutes, such as the Toxic Substances Control Act or the Federal Insecticide, Fungicide and Rodenticide Act, or through the conduct of an environmental risk assessment such as outlined in this work plan.

Remediation criteria protective of biota are not available for contaminants in soils, or for many of the contaminants that occur in aquatic ecosystems at hazardous waste sites. Remediation criteria protective of site-specific plants and animals for the contaminants of concern can be developed in this environmental evaluation based on ecological effects criteria and detailed food-web analyses using a calibrated/validated pathways model. Ecological effects criteria are determined by tracing the

TABLE 9-6
PROPOSED ENVIRONMENTAL EVALUATION REPORT OUTLINE
FOR WOMAN CREEK DRAINAGE

EXECUTIVE SUMMARY

1.0 INTRODUCTION

- 1.1 OBJECTIVES
- 1.2 SITE HISTORY
- 1.3 SCOPE OF EVALUATION

2.0 SITE DESCRIPTION

- 2.1 PHYSICAL ENVIRONMENT
    - 2.1.1 Air Quality/Meteorology
    - 2.1.2 Soils
    - 2.1.3 Surface Water
    - 2.1.4 Groundwater
- 2.2 BIOTIC COMMUNITY
    - 2.2.1 Freshwater Community
    - 2.2.2 Terrestrial Community
    - 2.2.3 Protected/Important Species and Habitats

3.0 CONTAMINANT SOURCES AND RELEASES

- 3.1 SOURCES
- 3.2 RELEASES

4.0 CONTAMINANTS OF CONCERN

- 4.1 CRITERIA DEVELOPMENT FOR SELECTION OF CONTAMINANTS OF CONCERN
- 4.2 DEFINITION OF CONTAMINANTS

5.0 TOXICITY ASSESSMENT

- 5.1 TOXICITY ASSESSMENTS OF CONTAMINANTS OF CONCERN
- 5.2 CONTAMINANT EFFECTS
    - 5.2.1 Terrestrial Ecosystems
    - 5.2.2 Aquatic Ecosystems

6.0 EXPOSURE ASSESSMENT

- 6.1 CONTAMINANT PATHWAYS AND ACCEPTABLE CRITERIA DEVELOPMENT
    - 6.1.1 General Methodology for Pathway Analysis
    - 6.1.2 Selection of Key Receptor Species
- 6.2 EXPOSURE POINT IDENTIFICATION
    - 6.2.1 Air
    - 6.2.2 Soil
    - 6.2.3 Sediment

TABLE 9-6

PROPOSED ENVIRONMENTAL EVALUATION REPORT OUTLINE FOR WOMAN CREEK DRAINAGE (Concluded)

biomagnification of contaminant residues from organisms at the top of the food web back through intermediate trophic levels to the abiotic environment. The "no effects" criteria levels for abiotic media are then derived from contaminant concentrations known to produce sublethal effects in the most sensitive (usually highest trophic level) organisms. Development of ecological effects criteria for OU5 will be based on results of the pathways model as well as available data which document potential adverse effects from contaminants of concern on key biological receptors. The process for establishing ecological criteria is shown in Figure 9-5. Determination of these criteria for OU5 will be coordinated with other RFI/RI studies and environmental evaluations.

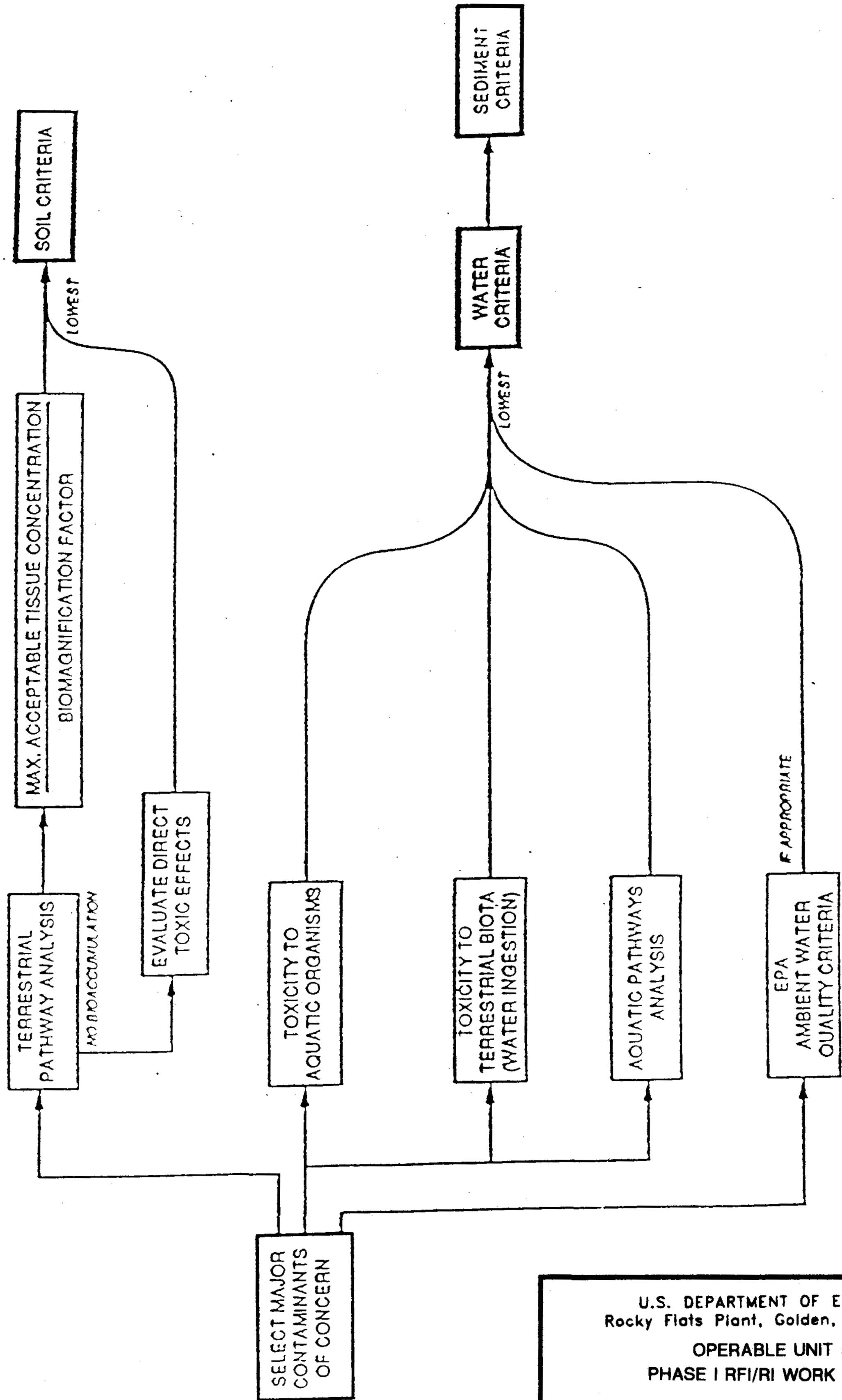
The acceptable (no-effects) criteria levels will be used in conjunction with ARARs to evaluate potential adverse effects on biota as appropriate for the environmental evaluation portion of the Phase I RFI/RI. This approach will be integrated with the Human Health Risk Assessment process and will assist in the development of potential remediation criteria.

9.3 FIELD SAMPLING PLAN

The OU5 Environmental Evaluation is planned in 10 tasks as described in Subsection 9.2. Field sampling activities will be conducted in Task 3 and Task 9 of the environmental evaluation. Task 3 will include brief field surveys, an ecological inventory of biota present at OU5, and initial aquatic toxicity testing. The field surveys and inventory will be conducted to obtain information on the occurrence, distribution, and general abundance of biota in OU5. Data obtained in the field inventory will be used to identify key receptor species, to develop a site-specific food web model and to provide input to the pathways analysis and contamination assessment. Planning for the Task 9 tissue analysis program will begin in Task 2 so that samples collected in the Task 3 field inventory may be used wherever possible (i.e., where contaminants of concern have been defined and field sampling protocol have been developed). Final determination of the need for further ecotoxicological studies in Task 9 will be made in Task 8, Planning, after completion of the contamination assessment.

The following field sampling plan is provisional and will be periodically revised as appropriate. The Task 3 sampling plan is largely complete but may be altered in order to better coordinate with the surface water and soil sampling programs for OU5 or other operable units. The Task 9 field sampling plan will be designed in greater detail after contaminants of concern and key receptor species have been identified and a preliminary determination of food webs and contaminant source-receptor pathways has been developed. This information will allow determination as to which contaminants of concern are likely to be present in sufficient concentrations to be detected in biota and which biota are most practical and suitable for sampling.

SOPs for sampling biota have been published as part of the Environmental Evaluation process at Rocky Flats. The SOPs include discussion of purpose and scope, responsibilities and qualifications, references,



SOURCE: REAGAN AND FORDHAM, 1991

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OUTLINE OF THE METHODOLOGY FOR DETERMINING CRITERIA FOR MAJOR CONTAMINANTS OF CONCERN

FIGURE 9-5 MAY 1991

equipment, and execution of protocols. Sampling procedures for the following organisms are included in the Ecology SOPs (Volume V):

- Periphyton
- Benthic macroinvertebrates
- Plankton
- Fish
- Large mammals
- Small mammals
- Birds
- Reptiles and amphibians
- Terrestrial arthropods
- Terrestrial vegetation
- Soil microbes

SOPs that are currently being developed in addition to the above include the following:

- Design of Field Sampling Plans
- Recording and Managing Data
- Preserving and Handling Samples
- Conducting Laboratory Studies
- Incorporating QA/QC

The preceding SOPS are referenced in the following OU5 Field Sampling Plan where appropriate.

9.3.1 Sampling Objectives

The Task 3 Ecological Field Investigation for OU5 has four broad objectives:

1. Conduct brief field surveys and an ecological inventory to describe the existing ecological setting in terms of habitats, vegetation, wildlife and aquatic species. Conduct initial aquatic toxicity testing using Ceriodaphnia spp. and fathead minnows. Observe OU5 for obvious signs or zones of contamination or injury to biota and their habitats. Accomplish ecological field inventory, through the use of established ecological field methodologies (e.g., Mueller-Dombois and Ellenberg 1974; Southwood 1978; Krebs 1989).

2. From the above data, identify key food web species which represent the major flow of energy and nutrients and thus the major pathways for contaminant transfer from physical environmental media to higher trophic-level ecological receptors.

3. Identify the presence or absence of protected or other important species and habitats.

4. Provide site-specific information for determining objectives, measurement endpoints and methodologies for Task 9 field/laboratory contamination studies.

Data from the field survey, inventory and aquatic toxicity tests will be summarized, tabulated and accompanied with a narrative description of the following data types:

- Species Present (Diversity)
- Habitat Descriptions/ Mapping Units (Clark et al. 1980)
- Soil Descriptions/ Classifications (part of RFI effort)
- Critical/ Protected Habitats
- Protected Species
- Terrestrial and Aquatic Food Webs
- Potential Exposure Pathways
- Abundance of Key Species
- Vegetation Cover
- Vegetation Frequency and Density (shrubs/trees)
- Vegetation Importance (community dominance) Values
- Aquatic Toxicity Test Results

Appropriate statistical tests will be used to analyze the data so that precision and accuracy of the results can be presented at a stated level of confidence. Depending on the data types being analyzed, within-and-between station differences, within-and-between season differences, and within-and-between species differences will be presented. Means, variances, standard errors, analyses of variance, regression, and correlation coefficients will be computed as appropriate. Where sample sizes are insufficient to detect differences, only descriptive statistics will be prepared.

9.3.2 Sample Location and Frequency

Both Task 3 and Task 9 field sampling activities for OU5 will be located and timed to the extent possible to coincide with collection of other media samples (soils, surface water, and groundwater) as well as sampling activities at other operable units. This integrated sampling approach is consistent with EPA guidance and will provide a synoptic view of potential contaminants in all relevant media at one time.

The field sampling plan for Task 3 is based on the assumption that brief field surveys will be conducted in the spring, summer, fall and winter and that the ecological field sampling program will take place within the May-June and July-August timeframes. Aquatic toxicity testing will take place in May-June (high flow) and September-October (low flow). Information from the initial surveys and field inventory may be used to modify sampling parameters for later field investigations.

Sampling locations are largely located at or downgradient from areas of known or suspected contamination. Sampling locations were selected to coincide with sampling efforts in abiotic media and to characterize the biotic communities that are present. The intent of the selected locations was not to test specific hypotheses regarding the effects of contamination, but to characterize the ecological communities that are present and provide site-specific input to the pathways model.

9.3.2.1 Locations for Vegetative Sampling

Vegetation sampling for phytosociological data will be performed at OU5 IHSSs, at the Surface Disturbance south of the Ash Pits, along the South Interceptor Ditch, and along Woman Creek. A systematic walk-through of these areas will be conducted in the spring, summer, and fall to observe species composition.

A stratified randomization procedure will be utilized to identify sampling locations for the quantitative vegetative description portion of the field inventory. The basis for selecting a random procedure of vegetation transect/plot location is to obtain as unbiased an estimator as possible of true population parameters for herbaceous cover and shrub/tree density and frequency. Stratification is required because several distinct vegetation types appear to be present in the study area, including prairie grassland, marsh, streambank vegetation, well-vegetated disturbed areas, and sparsely vegetated disturbed areas.

The basis for stratification will be a vegetation type map, to be prepared based on the 1975 University of Colorado vegetation map of Rocky Flats and the Clark et al. (1980) report, updated by visual observations during the field surveys. This map will cover Woman Creek Drainage.

Transects for the quantitative community surveys will be located near soil sampling sites (see Subsection 7.2) wherever possible. From each soil sampling point, the centerpoint of a vegetation transect will be selected based on a random distance (to 10 m) and random direction, using random numbers tables. Transect locations will be selected until an adequate number has been selected for each major vegetation type at each IHSS. Locations will be discarded under several conditions: where the selected location is in a vegetation type for which an adequate number of transects has already been selected (for each IHSS); where the vegetation is not homogeneous (i.e., located in more than one type or across an ecotone); and where the transect would be located in buildings or paved areas. A similar process will be used for transects along Woman Creek and the South Interceptor Ditch, where the sample locations will be located in the general area of the surface-water/sediment sampling points. Since vegetation types associated with these features tend to be linear, the randomization process may require limits on direction. Multiple transects will be located near (within 50 meters of) each surface water/sediment sampling point to provide an adequate sample size.

9.3.2.2 Locations for Periphyton, Macrobenthos and Fish Sampling

Periphyton, macrobenthos and fish samples will be collected at the following surface water sampling locations: SW-01, SW-02, SW-07, SW-26, SW-32, SW-36, SW-39, SW-46, SW-70, SW-126, Pond C-1, and Pond C-2 (Figure 9-6). Should the organisms or proper habitat be absent at a particular location, then the nearest location downstream with suitable habitat will be sampled and located on a map. Sampling at OU5 will be coordinated with OU5 surface water and sediment sampling activities as well with OU1 and OU2 sampling programs. Although sampling locations may be duplicated in the different work plans, such locations will only be sampled once. The resultant data will then be distributed for use in each of the appropriate work plans.

Both sediment and surface water quality data will be collected at the same locations and time as the aquatic biota sampling. Sampling locations may be altered to ensure these efforts are coordinated. Sampling locations for aquatic biota may also be altered depending on DQOs or required sample size.

9.3.2.3 Locations for Wildlife Sampling

A terrestrial wildlife inventory will be conducted within OU5 and along Woman Creek and the South Interceptor Ditch. Small mammal sampling will be conducted, to the extent possible, at the vegetative sampling locations. Searches for reptiles will be conducted in appropriate habitats in OU5.

9.3.2.4 Locations for Initial Toxicity Testing

Locations for initial aquatic toxicity testing will be mostly the same as those for periphyton, macrobenthos and fish sampling: SW-01, SW-02, SW-07, SW-26, SW-32, SW-36, SW-39, SW-46, SW-67, SW-70, SW-126, Pond C-1, and Pond C-2 (Figure 9-6). Toxicity testing activities for OU5 will be coordinated with toxicity testing activities proposed for OU2 and OU1 as part of the implementation of the field sampling effort.

9.3.2.5 Tissue Sampling Locations

Locations for the collection of tissue samples (terrestrial vegetation, periphyton, benthos, macrobenthos, fish) will be the same as those for terrestrial and aquatic sampling. An initial identification of species for tissue sampling will be made in Task 2. Additional sampling requirements will be determined during the contamination assessment (Tasks 4 through 7) and contaminant data from surface water, soil and sediment sampling. The intent is to collect tissue samples where existing abiotic media sampling has indicated significant contamination to occur. Development of the OU5 tissue sampling program will be coordinated with OU1 and OU2 programs.

9.3.2.6 Sample Frequency

Brief field surveys will be conducted during 1-week periods in the spring, summer, fall, and winter. Special note of transitory species, migratory species, and seasonal breeding habits will be made during these multi-season surveys.

Field inventory sampling will occur during the May-June and July-August timeframes. Samples collected during the inventory will be saved and used in the tissue analysis studies where sampling and analysis protocol have been established.

Initial toxicity tests will also be conducted during May-June (high flow) and September-October (low flow). Two acute and two chronic tests will be conducted within 1 to 2 weeks of each other during each season. If toxicity is observed in either acute or chronic tests at any one station, then a supplemental program will be designed for that location to determine if the toxicity is consistent and to determine the potential extent of the toxicant.

9.3.3 Reference Areas

Tissue analysis studies may require the sampling of contaminated and control areas in order to establish a relationship between contaminated conditions and background conditions in areas not exposed to Rocky Flats Plant contamination. Selection of reference areas may be based on criteria developed in the Task 1 preliminary planning process and may be coordinated with similar efforts at other operable units. Potential selection criteria include species to be sampled or similarity to OU5 in terms of topography, aspect, soils, vegetation, range type, and land use history. Reference areas should be upstream from drainage off Rocky Flats Plant and where windblown contaminants are of concern, upwind from prevailing air flow patterns through Rocky Flats Plant. Additional aquatic reference areas ideally should be located in Rock Creek, depending on the selected measurement endpoints. A site visit will be made of the proposed aquatic sampling locations for OU5, OU1, and OU2. Habitat characteristics will be noted if not previously recorded in ongoing Rocky Flats Plant studies (depth, flow, substrate type, pool/riffle, aquatic/streamside vegetation, etc.). This process will be repeated at potential reference sites.

Reference areas will be selected only after criteria, data quality objectives, and measurement endpoints are identified. The process for selecting reference areas will be developed in discussions and working sessions of the Risk Assessment Technical Working Group.

9.3.4 Field Survey and Inventory Sampling Methods

Sampling methods for periphyton, benthic macroinvertebrates, fish, mammals, birds, reptiles and amphibians, terrestrial arthropods, and terrestrial vegetation are detailed in the Ecology SOPs. The SOPs include several standardized forms to be used when sampling biota. Site Description Form 5.0D will be used for sampling terrestrial biota; stream and pond habitat description forms (Forms 5.0A and 5.0B) will be completed at each of the aquatic sampling locations. Chain-of-custody field sample forms will be completed where samples are collected for laboratory analysis or voucher specimens. Additional forms to be completed are specified in the following subsections.

9.3.4.1 <u>Vegetation</u>

Both qualitative and quantitative methods will be used to characterize the terrestrial and wetland vegetation at OU5. Qualitative surveys using a relevé analysis (see Ecology SOPs) will be conducted in the spring, summer, and fall to record the floristic composition of the plant communities present. These qualitative surveys will include a systematic walk-through of the IHSSs, Woman Creek, and the South Interceptor Ditch. Voucher specimens will be collected as necessary. The following data will be recorded on all vegetation species encountered:

- Scientific name
- Common name
- Life form
- Vegetative stage at the time
- Qualitative statement on condition
- Qualitative statement on abundance (relevé analysis - see Ecology SOPs)

Quantitative procedures will be used to collect structural and compositional data. Point-intercept transects will be used to collect data on species cover. Data will be recorded on Form 5.10B, Point-Intercept Data Form. Belt transects will be used in conjunction with the point-intercept transects to collect data on shrub cover and density. Trunk diameter, height, canopy diameter, and species will be recorded for any trees within the belt transect or within any IHSS. Shrub and tree data will be recorded on Form 5.10C, Belt Transect Data Form. Production data (standing biomass) will be collected from 1/4- to 1-m^2 quadrants at the same locations as the transects. Different quadrant sizes may be used depending on vegetation type (e.g., a 1/4-m^2 quadrant may be used on dense streambank vegetation). Production data will be recorded on Form 5.10D.

Each plot or transect will be considered as an observation in calculating the mean and variance. Sample adequacy will be determined for total herbaceous cover and total fresh weight biomass using Cochran's formula (1977):

$$N = \frac{(t^2)(s^2)}{[(x)(d)]^2}$$

where: N = the minimum number of samples needed
- t = t distribution value for a given level of confidence
- s^2 = the variance estimate
- x = the mean of the sample
- d = the level of accuracy desired

Sample adequacy will be obtained for each vegetation/habitat type within OU5. Where OUs overlap, habitats within the overlap area will only be sampled once and data will be applied to each OU. An 80% level of accuracy will be used to characterize total cover and total fresh weight in the vegetation communities. Where the vegetation community is disturbed or otherwise highly variable, a lower standard of accuracy may be used (e.g., 60%) to avoid excessive sampling.

9.3.4.2 Terrestrial Wildlife and Invertebrates

The Task 3 survey is planned to note the presence or absence of terrestrial/wetland species and to make note of their food habits. The survey procedure will include a systematic walk-through of OU5 area, including the South Interceptor Ditch and Woman Creek to record ecological features. Field data will be recorded on the standardized Qualitative Survey/Relative Abundance Data Form 5.0C for large mammals, small mammals, birds, reptiles and amphibians, and terrestrial arthropods. Opportunistic observations of bird and raptor nests, large mammal pellets and mammal burrow/dens will be recorded on the appropriate forms. Vocalization surveys for birds and anurans will also use the appropriate forms. Data to be recorded include:

- Species encountered/ observed
- Scientific name
- Common name
- Qualitative statement on:
  - Condition
  - Abundance
  - Habitat requirements

- Predator/prey species/food habits
- Regulatory status (to be determined prior to field sampling)

- Species presence will be determined by:

  - Visual observation
  - Vocalization
  - Burrow/den
  - Nest
  - Droppings/scat

Quantitative information on wildlife populations will be obtained in the Task 3 field inventory. Inventory sampling will include the following procedures, which are detailed in the SOPs:

- Live trapping of small mammals at each IHSS and along the South Interceptor Ditch and Woman Creek drainages. Data to be recorded include:

  - Scientific name/common name
  - Sex
  - Reproductive condition
  - Weight
  - Life history stage

- Reptile occurrence will be recorded along the same transects used for small mammal trapping in addition to habitat searches. Data to be recorded include:

  - Species encountered
  - Activity
  - Habitat
  - Qualitative statement on abundance

- Medium- and larger-sized mammals will be counted by recording all species along a systematic walk-through of OU5 including the South Interceptor Ditch and Woman Creek. The counting will occur during the small mammal transect trapping. Species encountered and activity will be recorded.

- Foliage invertebrates will be collected by sweep net and beating. Where conditions permit, foliage invertebrate and arthropod sampling may be conducted using a D-vac suction sampler in place of sweep netting (see Ecology SOPs). Data to be recorded will include:

- Host plant
- Herbivore
- Position in food web

9.3.4.3 Periphyton

Sampling to characterize periphyton communities will occur at the selected locations along Woman Creek, the South Interceptor Ditch and Ponds C-1 and C-2 (see SOP). Triplicate samples will be taken on a transect upstream and within 10 meters of the designated sampling locations. Data to be collected include:

- Scientific name
- Algal density (cell counts of each taxon)
- Biomass (chlorophyll-a and phaeophytin-a concentrations)

Field data will be recorded on the Periphyton Field Sample Form 5.1A (see SOP). Data from quantitative sampling will be used to determine species diversity and standing crop (biomass). Voucher samples will be retained. All analyses will be completed within 5 days of the collection of the slides from the field (U.S. EPA 1987b).

9.3.4.4 Macrobenthos

Benthic invertebrates are the most common fauna used in ecological assessments of contaminant releases and are defined as the invertebrates retained by screens of mesh size greater than 0.2 mm. Macrobenthos will be sampled at the aquatic sampling locations shown in Figure 9-6 using the procedures described in the SOPs. Triplicate samples will be taken on a transect upstream and within 10 meters of the designated sampling locations. Data to be collected include:

- Scientific name (generally to genus)
- Number of individuals in each taxon

Field data will be recorded on the Benthic Macroinvertebrate Field Sample Form 5.2A. Data from quantitative samples will be used to determine macroinvertebrate density (standing crop), taxa richness, and taxa diversity. Voucher specimens will be retained.

9.3.4.5 Fish

Fish will be collected in 10- to 25-meter-long collection areas using a backpack shocker or by seining blocked-off creek sections. In Ponds C-1 and C-2, fish will be sampled from a flat-bottom boat using an electroshocker. Data to be collected include:

- Scientific name
- Number of individuals in each taxon
- Length
- Weight

Scales will be collected to obtain data on age classes versus size, population structure and survivorship. Field data will be recorded on the Fish Field Inventory Form 5.4B (see SOP). Samples will be taken for laboratory identification/confirmation. Voucher specimens will be retained. Analyses will consist of compiling and summarizing the number, size, and weight of each species of fish captured at each sampling site. Graphic presentations may include fish length-frequency histograms and plots of catch-per-effort for each sampling area.

9.3.5 Initial Toxicity Tests

The initial toxicity testing program will be limited to aquatic organisms and will include standardized EPA acute and chronic tests with fathead minnows and Ceriodaphnia spp. Water samples will be cooled to 4°C and shipped to the laboratory conducting the toxicity tests within 12 to 24 hours. The toxicity tests will be initiated within 36 hours of the field collection time. The duration of the static renewal acute tests will be 48 hours for Ceriodaphnia spp. and 96 hours for fathead minnows. The test water will be renewed daily using dilution water from the sampling station. The static renewal chronic tests will last for 7 days for fathead minnows and until 60 percent of the Ceriodaphnia spp. in the control vessels have three broods. Quality control procedures will conform to the EPA requirements for NPDES toxicity testing currently being used at Rocky Flats and to the QAPjP.

9.3.6 Tissue Analysis Sampling Methods

The methodologies selected for tissue analysis studies will depend on the contaminants of concern and their anticipated effects on the selected key receptor species. Contaminants of concern and key receptor species will be determined as early as possible in Task 2. It is anticipated that some biota samples collected in the Task 3 field inventory can be used for tissue analysis. Standardized site protocol for preserving samples for tissue analyses will be followed in those instances where it is anticipated that tissue analyses will be conducted.

Analyses for metals and radionuclides in biota may call for a greater biomass of tissue than is available through standard collection methods. At least 80 grams of material (wet weight) is needed per sample for metals analysis, and 100 grams of material (dried and ashed) is needed for radionuclides. Obtaining this amount of sample may be impractical for some species of vegetation, periphyton, and macrobenthos. It is also not the intent of the sampling program to cause unnecessary disturbance or damage to the biota communities in order to collect sufficient samples. Sampling design will be adequate to ensure statistically valid results. DQOs for the tissue sampling program will be evaluated with respect to this determination prior to field collection activities.

Based on the literature reviewed and the information presented in this report, it is anticipated that most tissue samples will be analyzed for metals and very few samples, if any, may be analyzed for radionuclides. Tissue samples collected for contaminant analysis will be sent to a laboratory for specific metals and radionuclide analyses as determined in the preliminary Task 1/Task 2 environmental evaluation. Analytical methods will follow SOPs.

Holding times, preservation methods, sample containers, and field and laboratory quality control sample numbers are contained in the Quality Assurance Project Plan (QAPjP) and shown in Table 9-7. Tissue sampling protocol for biota are not necessarily standardized and may vary depending upon the laboratory conducting the analyses. Specific sample preparation requirements will be reported in SOPs which are currently in development.

9.3.7 Sampling Equipment

Equipment for field sampling of biota are identified in the Volume V Ecology SOPs.

9.4 SCHEDULE

The following Figure 9-7 presents a proposed schedule for implementation of the OU5 environmental evaluation. The schedule follows the task approach presented in this environmental evaluation. While many of the tasks are sequential, most tasks will overlap in time. The months indicated in the table reflect the timeframe in which the activity will occur and not necessarily the amount of time necessary to complete the task. The schedule is provisional and likely to change depending on the Phase I OU5 RFI/RI activity schedule as well as schedules from other operable units.

TABLE 9-7

HOLDING TIMES, PRESERVATION METHODS, AND SAMPLE CONTAINERS FOR BIOTA SAMPLES

	Holding Time From Date Collected	Preservation Method	Container	Approximate Sample Size++
SAMPLES FOR METALS ANALYSES				
Terrestrial Vegetation				
- Metals Determined by ICP**	6 mos	Freeze & ship w/ dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Metals Determined by GFAA+	6 mos.	Freeze & ship w/ dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Hexavalent Chromium	24 hours	Freeze & ship w/ dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Mercury	28 days	Freeze & ship w/ dry ice	Paper bag inserted into plastic bag and sealed	5 g
Periphyton, Benthic Macroinvertebrates, Fish				
- Metals Determined by ICP	6 mos.	Freeze & ship w/ dry ice	Plastic	25 g
- Metals Determined by GFAA	6 mos	Freeze & ship w/ dry ice	Plastic	25 g
- Hexavalent Chromium	24 hours	Freeze & ship w/ dry ice	Plastic	25 g
- Mercury	28 days	Freeze & ship w/ dry ice	Plastic	5 g

TABLE 9-7
(Concluded)

	Holding Time From Date Collected	Preservation Method	Container	Approximate Sample Size[++]
SAMPLES FOR RADIONUCLIDE ANALYSES				
Terrestrial Vegetation				
- Uranium-233, 234, 235, 238 Americium-241 Plutonium-239/240	6 mos	Freeze & ship w/ dry ice	Paper bag inserted into plastic bag and sealed	100 g
Periphyton, Benthic Macroinvertebrates, Fish				
- Uranium-233, 234, 245, 238 Americium-241 Plutonium-239/240	6 mos	Freeze & ship w/ dry ice	Plastic	100 g

**ICP = Inductively Coupled Argon Plasma Emission Spectroscopy. Metals to be determined include Ba, Cr, Cu, and Fe.

+GFAA = Graphite Furnace Atomic Absorption Spectroscopy. Metals to be determined include As, Cd, Li, Pg, Se, and Sr.

++ Sample size may vary with specific laboratory requirements.

10.0
QUALITY ASSURANCE ADDENDUM

The following document is the Quality Assurance Addendum which establishes the specific quality assurance controls applicable to the field investigation activities described in this RFI/RI Work Plan for OU5. This document was developed separately from the other sections of this report; therefore, this section is formatted differently. This section includes a separate table of contents, and the pages are numbered sequentially instead of sectionally.

Approved By:

TITLE:
Quality Assurance Addendum to the Rocky Flats Site-Wide Quality Assurance Project Plan for Operable Unit No. 5

_______________ __/__/__
Manager, Remediation Programs Date:

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INTRODUCTION AND SCOPE

This Quality Assurance Addendum (QAA) supplements the "Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities" (QAPjP), and establishes the specific quality assurance (QA) controls applicable to the field investigation activities described in the RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan for the Woman Creek Drainage (Operable Unit No. 5) (OU-5 Workplan).

1.0 ORGANIZATION AND RESPONSIBILITIES

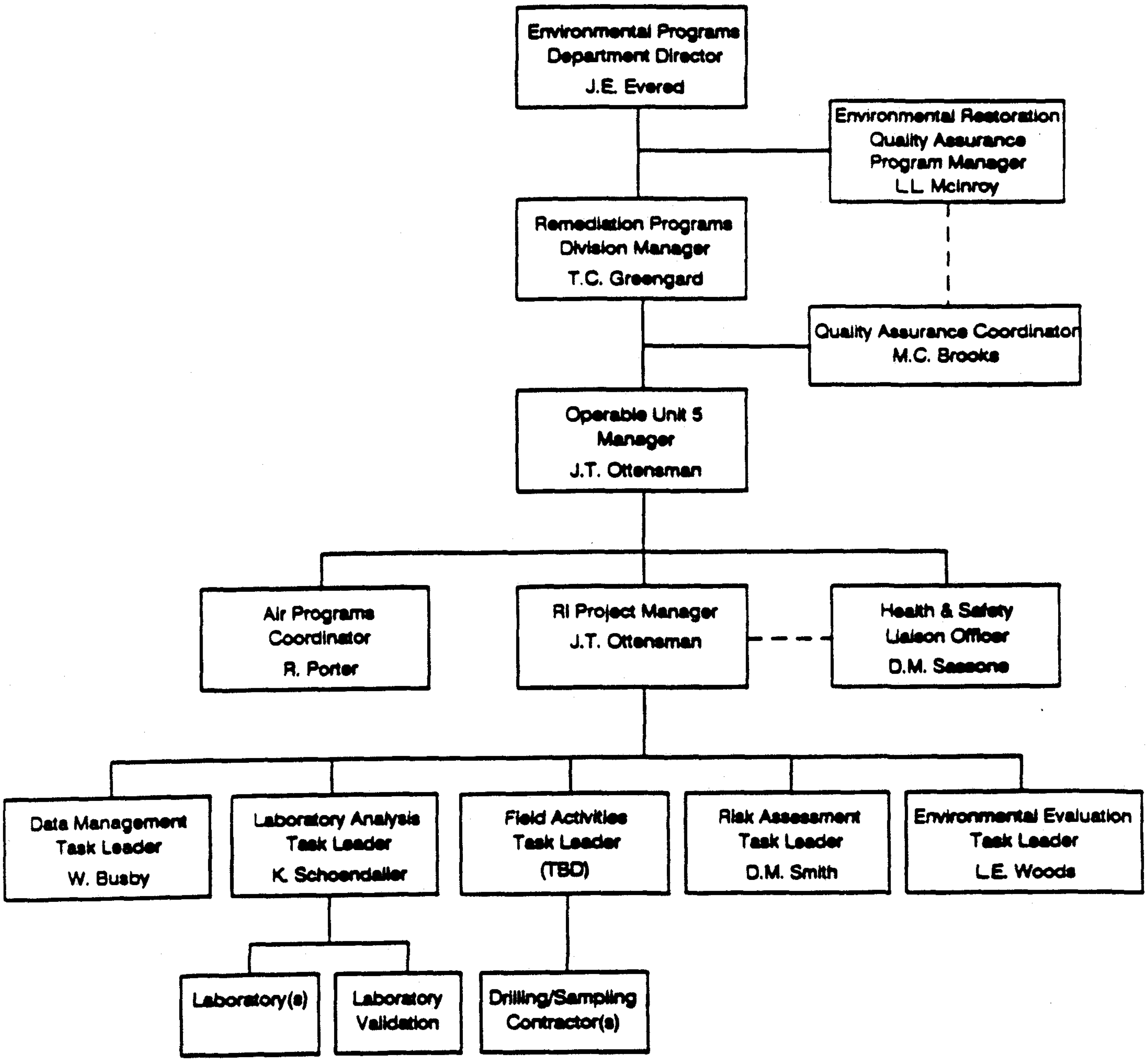
The overall organization of EG&G Rocky Flats and the Environmental Management (EM) divisions involved in environmental restoration (ER) activities is shown and described in detail in Section No. 1.0 of the QAPjP.

Contractors will be tasked by EG&G Rocky Flats to implement the field activities outlined in the OU-5 Workplan. The specific EM Department personnel who will interface with the Contractors and will provide technical direction are shown here in Figure 1.

2.0 QUALITY ASSURANCE PROGRAM

The QAPjP was written to address QA controls and requirements for implementing Interagency Agreement (IAG) related activities. As such, the controls and requirements addressed in the QAPjP are applicable to OU-5 RFI/RI activities, unless specified otherwise in this QAA. As a supplement to the QAPjP, this QAA addresses additional and site-specific QA controls and requirements that are applicable to OU-5 RFI/RI activities.

FIGURE 1. PROJECT MANAGEMENT FOR OPERABLE UNIT 5, WOMAN CREEK DRAINAGE, PHASE I RFI/RI



2.1 Training

All EM Department and contractor personnel performing field activities at OU-5 shall complete the minimum training requirements specified in Section 2.0 of the QAPjP. In addition, all personnel performing activities in accordance with the Standard Operating Procedures (SOPs) specified in this QAA shall receive documented training on the QAPjP, QAA, and training specified in the applicable SOPs prior to performing the work. Such personnel include, but are not limited to, those performing or supervising the following activities:

- Drilling/boring;
- Installation/completion of groundwater monitoring wells;
- Sample collection (all media);
- Sample chain-of-custody/preservation/handling;
- Equipment decontamination;
- Field measurements (e.g., pH, conductivity, temperature, dissolved oxygen, water level);
- Water level measurements;
- Data validation; and
- Environmental surveying and sample collection.

3.0 DESIGN CONTROL AND CONTROL OF SCIENTIFIC INVESTIGATIONS

The OU-5 Workplan is the investigation control plan for the RFI/RI activities to be conducted in the Woman Creek Drainage Area. The sampling rationale and investigation program, including sample locations, frequency, and analytical requirements, are presented in the OU-5 Workplan, and are summarized in this QAA. Specific SOPs to be implemented by EG&G Rocky Flats and contractor personnel during all aspects of the field investigation are also identified here.

In addition to the Field Sampling Plan activities described in Section 7.2 of the OU-5 Workplan, environmental evaluation (EE) field activities will be conducted as described in Section 9.0 of the OU-5 Workplan. These EE activities include:

- Performing aquatic and terrestrial field surveys,

- Collecting and analyzing terrestrial and aquatic biota samples, and
- Performing toxicity tests to measure the effects of contaminated environmental media on representative species.

Sample locations, frequency, and analyses are presented in the OU-5 Work Plan (Section 7.0) and are summarized in this QAA. Specific SOPs to be implemented by EG&G Rocky Flats and Contractor personnel during all aspects of the field investigation are also identified here.

3.1 Data Quality Objectives

3.1.1 Objectives

The OU-5 Workplan is designed to characterize the physical and hydrologic setting of the Individual Hazardous Substance Sites (IHSSs) within the OU-5 area, assess the presence or absence of contamination, characterize the nature and extent of contamination at the sites, and support the Baseline Risk Assessment and Environmental Evaluation. The following activities will be performed as part of the OU-5 RFI/RI Field Sampling Plan:

- Review existing data, including aerial photographs and site records;
- Conduct field screenings, including radiation and gas surveys;
- Collect surface water and sediment samples;
- Drill to collect soil samples at depth and characterize subsurface soil, geologic, and hydrogeologic conditions; and
- Install and sample groundwater monitoring wells.

Site-specific RFI/RI objectives/data needs and corresponding methods of sampling/analysis are outlined in Table 4-1 of the OU-5 Workplan.

Table 4-1 of the OU-5 Workplan also lists the analytical levels that are appropriate to the RFI/RI objectives/data needs and data uses. (These analytical levels are discussed and described in Appendix A of the QAPjP.) The analytical levels for the Phase I investigations include levels I - V. The data quality objectives for analytical level I and II field measurement, sampling, and analysis activities consist of establishing instrument readability or detection limits and accuracy objectives. Accuracy objectives for field instruments will be determined by calibrating instruments to known standards. Readability/detection limits and accuracy objectives for field instruments are listed in Appendix A.

The analytical program requirements for the various media at each of the OU-5 IHSSs are discussed in Section 7.3 and summarized in Table 7-6 of the OU-5 Workplan. The analytical program specifies the use of analytical methods referenced in the EG&G Rocky Flats General Radiochemistry and Routine Analytical Services Protocol (GRRASP) for all analytes listed in Table 7-6. The precision, accuracy, and completeness parameters for analytical levels III-V are discussed below, along with comparability and representativeness for all levels.

3.1.2 Precision and Accuracy

The objective of precision and accuracy are dependent on the analyte of interest, the sample matrix, the analytical method, and the quality controls that ate applicable to the analytical method. The groundwater, surface water, sediment, and soil samples collected during OU-5 investigations will be analyzed according to the methods specified in the Rocky Flats General Radiochemistry and Routine Analytical Services Protocol (GRRASP), which includes U.S. Environmental Protection Agency (EPA) Contract Laboratory Program (CLP) protocols and standard EPA methods when CLP protocols are unavailable. The analytes of interest for OU-5 investigations are listed in Table 7-5 of the OU-5 Workplan. The objectives for precision and accuracy for the analytes identified for each sample matrix are presented in Appendix A of this QAA.

3.1.3 Completeness

The target completeness objective for both field and analytical data for this project is 100 percent with a minimum acceptability of 90 percent.

3.1.4 Comparability

Comparability is a qualitative parameter that shall be ensured by implementation of an approved sampling and analysis plan, standardized analytical protocols, and SOPs for field investigations (discussed in Section 11 of the OU-5 Workplan and listed here in Table 1), and by reporting data in uniform units as specified in the OU-5 Workplan and SOPs listed in Table 1.

3.1.5 Representativeness

Representativeness is a qualitative parameter that is ensured through the careful development and review of the sampling and analysis strategy outlined in the OU-5 Workplan and SOPs for sample collection and analysis and field data collection.

3.1.6 DQOs for Environmental Evaluation Investigations

The overall objective of the EE is to determine the nature and extent of potential impacts of OU-5 contaminants on biota. The field sampling activities discussed in the EE Field Sampling Plan (Section 9.3 of the OU-5 Workplan) are intended to characterize current biological site conditions in terms of species diversity, habitat characteristics, community structure, and contamination concentration in receptor species. The emphasis of the qualitative and quantitative field surveys will be to describe the characteristics of the biological communities at OU-5 in order to identify potential contaminant pathways, biotic receptors, and key species.

This characterization of current biological site conditions is considered a screening process that requires analytical level I and II measurement data. Data quality for these characterization activities will be controlled by adhering to the field sampling SOPs in implementing the Field Sampling Plan. Precision and accuracy of the quantitative field measurements collected to estimate diversity, abundance, cover, production, frequency, density, and initial aquatic toxicities will be determined by appropriate statistical analyses. Statistical means, variances, standard errors, analysis of variance, and regression and correlation coefficients will be computed as appropriate.

Site characterization data developed from the OU-5 EE and RFI/RI will be used to develop the conceptual model for the OU-5 ecosystem, and, together with the conceptual model, will assist investigators with identifying key receptor species, contaminants of concern, and potential exposure pathways. Once potential exposure pathways and key receptor species are identified, direct measurements of tissue analysis can be conducted. Additional DQOs for tissue analysis

TABLE 1
Standard Operating Procedures and Field Activities for Which They are Applicable

Former SOP Reference Number	New EMAD OP Reference Number	Standard Operating Procedures	Field Screening Surveys	Well Drilling, Completion, Development	Ground-Water Sampling	Surface-Water Sampling	Sediment Sampling	Surface Soil Sampling	Subsurface Soil/Mat. Sampling	Source Sampling	Biota Sampling
1.1	FO.17	Wind Blown Contaminant Dispersion Control	●					●			
1.2	FO.12	Field Document Control	●	●	●	●	●	●	●	●	●
1.3	FO.09	General Equipment Decontamination	●	●	●	●	●	●	●	●	●
1.4	FO.10	Heavy Equipment Decontamination		●	●	●	●	●	●	●	●
1.5	FO.04	Handling of Purge and Development Water		●	●						
1.6	FO.05	Handling of Personal Protective Equipment	●	●	●	●	●	●	●	●	●
1.7	FO.11	Handling of Decontamination Water & Wash Water	●	●	●	●	●	●	●	●	●
1.8	FO.06	Handling of Drilling Fluids & Cuttings		●			●		●		
1.9	FO.07	Handling of Residual Samples						●	●	●	●
1.10	FO.01	Receiving, Labeling, and Handling Waste Containers		●	●				●	●	●
1.11	FO.14	Field Communications	●	●	●	●	●	●	●	●	●
1.12	FO.18	Decontamination Facility Operations	●	●	●	●	●	●	●	●	●
1.13	FO.02	Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples			●	●	●	●	●	●	●
1.14	FO.15	Field Data Management	●	●	●	●	●	●	●	●	●
1.15	FO.03	Use of PIDs and FIDs		X	X	X	X	X	X	X	X
1.16	FO.08	Field Radiological Measurements	●	X	X	X	X	X	X	X	X
2.1	GW.01	Water Level Measurements in Wells and Piezometers		●	●						
2.2	GW.02	Well Development									
		a) New Wells		●							
		b) Redevelopment		●							
2.5	GW.04	Measurements for Groundwater Field Parameters			●						
2.6	GW.05	Groundwater Sampling			●						

X - As required by H&S plan.

TABLE 1 (Continued)
Standard Operating Procedures and Field Activities for Which They are Applicable

Former SOP Reference Number	New EMAD OP Reference Number	Standard Operating Procedures	Field Screening Surveys	Well Drilling, Completion, Development	Ground-Water Sampling	Surface-Water Sampling	Sediment Sampling	Surface Soil Sampling	Subsurface Soil Sampling	Source Sampling	Biota Samples
3.1	GT.09	Logging Alluvial and Bedrock Material		●					●		
3.2	GT.01	Drilling and Sampling Using Hollow-Stem Auger Techniques		●					●		
3.5	GT.04	Plugging and Abandonment of Boreholes		●					●		
3.6	GT.05	Monitoring Well and Piezometer Installation		●							
3.8	GT.07	Surface Soil Sampling						●			
3.9	GT.11	Soil Gas Sampling and Field Analysis	●								
3.10	GT.10	Borehole Clearing							●		
3.11	GT.12	Plugging and Abandonment of Wells		●							
4.1	SW.01	Surface Water Data Collection Activities				●					
4.2	SW.02	Field Measurement of Surface Water Parameters				●					
4.3	SW.03	Surface Water Sampling				●					
4.6	SW.04	Sediment Sampling					●				
4.8	SW.08	Pond Sampling				●					
5.1	EE.01	Sampling of Periphyton									●
5.2	EE.02	Sampling of Benthic Macroinvertebrates									●
5.3	EE.03	Sampling of Plankton									●
5.4	EE.04	Sampling of Fishes									●
5.5	EE.05	Sampling of Large Mammals									●
5.6	EE.06	Sampling of Small Mammals									●
5.7	EE.07	Sampling of Birds									●
5.8	EE.08	Sampling of Reptiles and Amphibians									●
5.9	EE.09	Sampling of Terrestrial Arthropods									●
5.10	EE.10	Sampling of Terrestrial Vegetation									●
5.11	EE.11	Identification of Habitat Types									●
5.12	EE.12	Sampling of Soil for Soil Description									●
5.13	EE.13	Development of Field Sampling Plans									●

measurement data and measuring ecotoxicological endpoints will be developed following steps recommended by EPA in EPA/600/3-89/013, Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document, and EPA/540/G-90/008, Guidance for Data Usability in Risk Assessment. The biological site characterization data that will be obtained by implementing the Field Sampling Plan are needed to develop these additional DQOs.

3.2 Sampling Locations and Sampling Procedures

The RFI/RI field investigation programs, including sampling procedures and sampling locations, for each IHSS within the OU-5 area are described in Section 7.2 and summarized in Tables 7-1 through 7-4 of the OU-5 Workplan.

3.2.1 Soil Gas Surveys and Soil Cores

A real time soil gas survey, with soil gas samples taken on a 100-foot grid, will be conducted over the Original Landfill and the disturbed area located to the east of the landfill (OU-5 Workplan, Figure 7-1). Soil gas surveys will be conducted according to SOP 3.9, Soil Gas Sampling and Field Analysis. Soil cores will be collected for laboratory analysis of Volatile Organic Compounds (VOCs) after every 50 soil samples. The soil cores will be collected at the same depth as the soil gas samples. Soil cores will be collected using the drive sample method described in SOP 3.2, Drilling and Sampling Using Hollow-Stem Auger Techniques.

3.2.2 Radiation Surveys

Radiation surveys, using a side-shielded field instrument for detection of low energy radiation (FIDLER), will be performed at IHSS 133 - Ash Pits 1-4, Incinerator, and Concrete Wash Pad (OU-5 Workplan, Figure 7-3) and IHSS 209 - Surface Disturbance Southeast of Building 881 and Other Surface Disturbances (OU-5 Workplan, Figure 7-4). The radiation readings will be taken on a 10-foot grid over the areas. Radiation surveys will be conducted according to SOP 1.16, Field Radiological Measurements.

3.2.3 Soil Samples from Soil Borings

Soil samples will be collected from six soil borings at the disturbed area east of the original landfill and one soil boring from the former evaporation settling pond (OU-5 Workplan, Figure 7-1). Soil samples will be collected from soil borings placed on 25-foot centers along the long axis of ash pits 1-4 and the incinerator and concrete wash pads (OU-5 Workplan, Figure 7-3). Soil samples from the surface disturbance area south of the ash pits will be collected from two soil borings in each trench, four borings in the west fill area, and one in the east fill area (OU-5 Workplan, Figure 7-3). Soil samples will be taken continuously in these borings, with discrete samples collected from every 2-foot increment. Soil borings and subsurface soil samples will be done according to techniques described in SOP 3.2. The continuous core samples will be logged according to SOP 3.1, Logging Alluvial and Bedrock Material.

3.2.4 Surface Water and Sediment Samples

Figures 7-1 and 7-2 of the OU-5 Workplan show the locations of surface water and sediment sampling locations, respectively, for OU-5. Sampling locations include the following:

- Three locations along the South Interceptor Ditch,
- Two locations on Woman Creek,
- Five samples from each of the two C-Series Detention Ponds,
- One sediment sample and surface water (if present) from the deepest part of both pond-like depressions at IHSS 209,
- Four locations west of OU-5 to provide background data on Woman Creek.

In addition to the above, sediment samples will be collected within the creek or ditch along Woman Creek between the Concrete Wash Pad and Pond C-1 (11 samples), along Woman Creek between Pond C-1 and C-2 (four samples), along the South Interceptor Ditch between the Original Landfill and Pond C-2 (ten samples), and along Woman Creek between Pond C-2 and Indiana Street (four samples). Surface water data collection, field measurements, and sampling will be conducted according to SOPS 4.1, Surface Water Data Collection Activities, 4.2, Field Measurements of Surface Water Parameters, and 4.3, Surface Water Sampling. Pond sampling will be conducted according to SOP 4.8 and the addendum to SOP 4.8, Pond Sampling. Sediment sampling will be conducted according to SOP 4.6, Sediment Sampling.

3.2.5 Surface Soil Samples

Surface soil samples will be collected at the central location of all areas identified by the radiation survey as having above-background radiation levels and at stained areas identified during visual inspections. A surface soil sample will also be collected from the ditch between the east and west fill areas (OU-5 Workplan, Figure 7-3). Surface soil sampling will be conducted according to SOP 3.8, Surface Soil Sampling.

3.2.6 Groundwater Samples

If soil borings are used to transect soil gas plumes (indicated from soil gas surveys), monitoring wells will be installed to collect groundwater samples. Groundwater monitoring wells will be installed in the alluvial aquifer downgradient of the Original Landfill (three wells - OU-5 Workplan, Figure 7-1), downgradient of the Ash Pits (three wells - OU-5 Workplan, Figure 7-3), and immediately downgradient form Detention Ponds C-1 and C-2 (two wells per pond for a total of four - OU-5 Workplan, Figure 7-4). The wells will be drilled according to SOP 3.2, installed according to SOP 3.6, Monitoring Well and Piezometer Installation, and developed according to SOP 2.2, Well Development. Groundwater sampling will be done according to SOPs 2.5, Measurements for Groundwater Field Parameters, and 2.6, Groundwater Sampling. The frequency and duration of sampling the monitoring wells is specified in Section 7.2 of the OU-7 Workplan.

3.3 Analytical Procedures

The analytical program for OU-5 RFI/RI activities is discussed in Section 7.3 of the OU-5 Workplan. The analytical methods that shall be adhered to are those that are specified in the GRRASP. These methods are referenced in Section No. 3 of the QAPjP. Specific analytical methods for each analyte are also referenced here in Appendix A.

3.4 Environmental Evaluation: Summary of Surveying and Sampling

The EE Workplan (Section 9 of the OU-5 Workplan) consists of 10 Tasks. The field sampling plan (Section 9.2) encompasses Task 3, Ecological Field Investigation and initial tissue sample collection of Task 8, Ecotoxicological Field Investigations. The ecological field investigations that will be conducted include qualitative and quantitative field surveys and sampling of terrestrial and aquatic ecosystems. The identification and delineation of habitats and vegetation mapping units will be done according to SOP 5.11, Identification of Habitat Types.

Terrestrial ecosystem sampling will be conducted to gather data for construction of food web and exposure pathways, and will include the following:

- Field surveys to estimate the relative abundance and distribution of large mammals according to SOP 5.5, Sampling of Large Mammals.
- Field surveys and small mammal trapping to estimate relative abundance and habitat use according to SOP 5.6, Sampling of Small Mammals. Collection of small mammals for tissue analyses of contaminant concentrations (Task 8) will occur at the conclusion of the spring and fall live-trapping session according to SOP 5.6.
- Field surveys of reptiles and amphibians according to SOP 5.8, Sampling of Reptiles and Amphibians. Collection for tissue analysis in not anticipated.
- Field surveys and composite samples of terrestrial arthropods to estimate relative abundance and tissue analysis according to SOP 5.9, Sampling of Terrestrial Arthropods.
- Vegetation surveys and sampling to provide estimates of species composition, richness, dominance, cover, production, and for tissue analysis according to SOP 5.10, Sampling of Vegetation.

Aquatic habitats within OU-5 will be sampled to assess species composition, relative abundance, and contaminant loads of fish and benthic macroinvertebrates for use in contaminant pathway models and food web analysis. Sampling will consist of the following:

- Periphyton and plankton will be sampled to determine species composition and primary production according to SOPs 5.1, Sampling of Periphyton, and 5.3, Sampling of Plankton.
- Benthos communities will be sampled to determine the composition and relative abundance of species present and to provide composite samples of select taxa for tissue analysis according to SOP 5.2, Sampling of Benthic Macroinvertebrates.
- Fish surveys and sampling for tissue analysis will be done according to SOP 5.4, Sampling of Fishes.

Reference areas for the EE investigations will be selected according to SOP 5.13, Development of Filed Sampling Plans, primarily for tissue sampling tasks.

The data collected from implementation of the field investigations described in the field sampling plan will be used to select target species and contaminants of concern for contamination assessments and ecotoxicological studies. This data will in turn be used in the ecological risk assessment to determine the nature and extent of potential impacts of OU-5 contaminants on biota.

3.5 Equipment Decontamination

Non-dedicated sampling equipment shall be decontaminated between sampling locations in accordance with SOP 1.3, General Equipment Decontamination. Other equipment (e.g., heavy equipment) potentially contaminated during drilling, hydrogeologic/geologic testing, boring, sample collection, etc. shall also be decontaminated as specified in SOP 1.4, Heavy Equipment Decontamination.

3.6 Air Quality

Ambient air concentration modeling to estimate environmental risk which results from airborne transport of OU-5 contaminants to potential receptors is discussed in Section 9 of the OU-5 Workplan.

3.7 Quality Control Samples

To assure the quality of the field sampling techniques, collection and/or preparation of field quality control (QC) samples are incorporated into the sampling scheme. Field QC samples and collection frequencies for the field investigations are shown in Table 2. A specific sampling schedule will be prepared by the sampling subcontractor for approval by the EG&G Laboratory Analysis Task Leader (Figure 1) prior to sampling.

In addition, a QC sample, which will consist of an extra volume of a designated field sample, shall be collected at a 5-percent frequency for each specific sample matrix. These QC samples shall be collected and submitted to the laboratory to allow for the analysis of laboratory prepared QC samples to provide the laboratory with a check on its internal operations. The volume required for the QC sample shall be double that of a normal sample.

3.7.1 Objectives for Field QC Samples

Equipment rinsate blanks are considered acceptable (with no need for data qualification) if the concentration of analytes of interest is less than three times the required detection limit for each analyte as specified in Appendix A. Field duplicate samples will agree within 30 percent relative percent difference for aqueous samples and 40 percent for homogenous, non-aqueous samples.

Trip blanks and field preservation blanks (for organics and inorganics, respectively) indicate possible field contamination when analytes are detected above the minimum detection limits presented in Appendix A. The EG&G Laboratory Analysis Task Leader or laboratory validation contractor (Figure 1) will be responsible for verifying these criteria and shall be responsible for checking to see if the criteria are met and for qualifying data.

TABLE 2
FIELD QC SAMPLE COLLECTION FREQUENCY

Activity	Frequency
Field Duplicate	1 in 10[1]
Field Preservation Blanks[2]	1 sample per shipping container (or a minimum of 1 per 20 samples)
Trip Blank[3]	1 in 20[4]
Equipment Rinsate Blank	1 in 20[5] or 1 per day, whichever is more frequent.
Triplicate Samples (benthic samples)	For each sampling site.

1. Or per sampling event, whichever is more frequent.
2. For samples to be analyzed for inorganics and radionuclides.
3. For samples to be analyzed for volatile organics only.
4. A trip blank shall not be used for radiochemistry samples because radionuclide samples are less likely to be contaminated from direct exposure to air than are samples of volatile organics.
. One equipment rinsate blank in twenty samples or one per day <u>for each specific sample matrix being collected</u> when non-dedicated equipment is being used.

3.7.2 Laboratory QC

Laboratory QC procedures are used to provide measures of internal consistency of analytical and storage procedures. The laboratory contractor will submit written SOPs to the EG&G Laboratory Analysis Task Leader for approval. The interlaboratory SOPs shall be consistent with or equivalent to EPA-CLP QC procedures. The laboratory SOPs must cover the following areas in sufficient detail, and reflect actual operating conditions in effect during analysis of EG&G RFP samples:

- Sample receipt and log-in
- Sample storage and security
- Facility security
- Sample tracking (from receipt to sample disposition)
- Sample analysis method references
- Data reduction, verification, and reporting
- Document control (including submitting documents to EG&G)
- Data package assembly (see Section III.A of the GRRASP)
- Qualifications of personnel and resumes
- Preparation of standards
- Equipment maintenance and calibration
- List of instrumentation and equipment (including date purchased, date installed, model number, manufacturer, and service contracts, if any)
- Instrument detection limits
- Acceptance criteria for non-CLP analyses
- Laboratory QC checks applicable to each analytical method

Laboratory QC techniques to ensure consistency and validity of analytical results (including detecting potential laboratory contamination of samples) include using reagent blanks, field blanks, internal standard reference materials, laboratory replicates, and field duplicates. The laboratory contractor will follow the standard evaluation guidelines and QC procedures, including frequency of QC checks, that are applicable to the particular type of analytical method being used as specified in the GRRASP and Section No 3.0 of the QAPjP. All results will be forwarded to the laboratory analysis task leader and validation contractor (Figure 1) for review and verification.

3.8 Quality Assurance Monitoring

To assure overall quality of each IAG deliverable required by this activity, a Readiness Review will be conducted under the direction of the EM Department QAPM prior to implementing the activities addressed by the OU-5 Workplan. The Readiness Review will determine if all activity prerequisites have been met that are required to begin work. The Readiness Review will address work prerequisites contained in this QAA, the QAPjP, the SOPs listed in Table 1, the RFP Site Health and Safety Plan, the IAG, and other applicable RFP, local, State, and Federal regulations. Any deficiencies noted during the Readiness Review will be noted in a Corrective Action Report (CAR), which will be processed as outlined in Section No. 16.0 of the QAPjP.

In addition to readiness reviews, daily inspections will be conducted of the field activities described in the OU-5 Workplan by independent personnel under the direction of the Remediation Programs Division (RPD) Quality Coordinator. Any nonconformances or significant conditions adverse to quality will be noted during these inspections, and Nonconformance Reports (NCRs) and CARs will be issued and processed as outlined in Sections 15.0 and 16.0 of the QAPjP. In addition to these inspections, surveillances and audits will be conducted by independent personnel outside the RPD as outlined in Section 18.0 of this QAA.

3.9 Data Reduction, Validation, and Reporting

3.9.1 Analytical Reporting Turnaround Times

Analytical reporting turnaround times are as specified in Table 3-1 of the QAPjP.

3.9.2 Data Validation

Guidelines used to evaluate analytical data are referenced in subsection 3.4.2 of Section No. 3.0 of the QAPjP. The laboratory validation process is also illustrated in Figure 3-1 of Section No. 3 of the QAPjP. Field data validation will be performed as specified in subsection 3.4.2 of Section No. 3.0 of the QAPjP. The DQOs for validating the OU-5 measurement data are presented here in Appendix A. The process of sample collection, field data validation, sample transfer (chain-of-custody), sample analysis and data validation is illustrated in Figure 8-1 of Section No. 8 of the QAPjP. The standards and criteria used to determine the validity and usability of RFP ER program data are described in subsection 3.7 of Section No. 3.0 of the QAPjP.

3.9.3 Data Reduction

Reduction of field and laboratory data shall comply with the data reduction functions summarized in subsection 3.4.1 of Section No. 3.0 of the QAPjP. Laboratory data reduction will comply with the data deliverable requirements specified in the GRRASP. Field data reduction shall be conducted in accordance with SOP 1.14, Field Data Management. The reduced data will be used in the data validation process to verify that the laboratory field controls and DQOs for measurement of data have been met.

3.9.4 Data Reporting

Depending on the data validation process, data are flagged as either "valid," "acceptable with qualifications," or "rejected." the results of the data validation shall be reported in EM Department Data Assessment Summary reports. The usability of data (the criteria of which is also described in subsection 3.3.7 of Section No. 3.0 of the QAPjP) shall also be addressed by the RI Project Manager.

4.0 PROCUREMENT DOCUMENT CONTROL

Contractors will perform the field investigation described in the OU-5 Workplan. The Contractors will be required to implement all requirements contained in the OU-5 Workplan, the QAPjP, this QAA, and all applicable SOPs referenced in these documents. Analytical services will also be contracted for analysis of field samples. Appropriate requirements from the QAPjP, this QAA, and the GRRASP shall be passed on to any organizations performing these analyses. Contractors may also be utilized to validate analytical data packages. Applicable requirements from the QAPjP and this QAA shall be transmitted to the validation Contractor.

The implementing Contractors will be required to provide the materials necessary for performing the work described in the OU-5 Workplan.

Contractors may be required to submit a QA Program that meets the applicable requirements of the QAPjP and this QAA.

5.0 INSTRUCTIONS, PROCEDURES, AND DRAWINGS

The OU-5 Workplan describes the activities to be performed. The plan will be reviewed and approved in accordance with the requirements for instructions, procedures, and drawings outlined in Section No. 5.0 of the QAPjP.

SOPs approved for use are identified in Table 1, which also indicates their applicability. Environmental survey and sampling methods for environmental evaluations are discussed in the OU-5 Workplan. Any additional quality-affecting procedures proposed for use but not identified here will be developed and approved as required by Section 5.0 of the QAPjP prior to performing the affected activity.

Section 11.0 of the OU-5 Workplan includes SOP addenda for RFI/RI investigations at OU-5 for SOPs 4.6, Sediment Sampling, and 4.8, Pond Sampling. Rather than develop SOP addenda, Procedure Change Notes (PCNs) (referred to as a Procedure Deviation Notice in Rev.0 of Section No. 5.0 of the QAPjP) will be prepared for changes to approved SOPs.

6.0 DOCUMENT CONTROL

The following documents will be controlled in accordance with the document control requirements of Section No. 6.0 of the QAPjP:

- RFI/RI Work Plan for Woman Creek Priority Drainage (Operable Unit No. 5);
- "Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigations/Feasibility Studies and RCRA Facilities Investigations/Corrective Measures Studies Activities" (QAPjP);

- Quality Assurance Addendum (QAA) to the Rocky Flats QAPjP for Operable Unit No. 5, Woman Creek Priority Drainage RFI/RI Activities;
- SOPs (all SOPs specified in this QAA).

7.0 CONTROL OF PURCHASED ITEMS AND SERVICES

Contractors that provide services to support the OU-5 Workplan activities will be selected and evaluated as outlined in Section No. 7.0 of the QAPjP. This includes preaward evaluation/audit of proposed Contractors as well as periodic audit of the acceptability of Contractor performance during the life of the contract. Such audits shall be performed at least annually or once during the life of the project, whichever is more frequent. Also see Section No. 18.0 of the QAPjP.

8.0 IDENTIFICATION AND CONTROL OF ITEMS, SAMPLES, AND DATA

8.1 Sample Containers/Preservation

Appropriate volumes, containers, preservation requirements, and holding times for samples are presented in Tables 8-1 through 8-4 of Section No. 8.0 of the QAPjP. Requirements for environmental evaluation are included here in Table 3.

8.2 Sample Identification

RFI/RI samples shall be labeled and identified in accordance with subsection 3.2.2 of Section No. 8.0 of the QAPjP and the SOPs referenced here in Table 1. Samples shall have unique identification that traces the sample to the source(s) and indicates the method(s), date, the sampler(s), and conditions prevailing at the time of sampling. Sample identification requirements for environmental evaluation samples will be specified in the EE field sampling SOPs.

TABLE 3

HOLDING TIMES, PRESERVATION METHODS, AND SAMPLE CONTAINERS FOR BIOTA SAMPLES

	Holding Time From Date Collected	Preservation Method	Container	Approximate Sample Size*
SAMPLES FOR METALS ANALYSES				
TERRESTRIAL VEGETATION				
- Metals Determined by ICP**	6 mos.	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Metals Determined by GFAA***	6 mos.	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Hexavalent Chromium	24 hours	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	25 g
- Mercury	28 days	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	5 g
Periphyton and Benthic Macroinvertebrates				
- Metals Determined by ICP**	6 mos.	Freeze & ship w/dry ice	Plastic	25 g
- Metals Determined by GFAA***	6 mos.	Freeze & ship w/dry ice	Plastic	25 g
- Hexavalent Chromium	24 hours	Freeze & ship w/dry ice	Plastic	25 g
- Mercury	28 days	Freeze & ship w/dry ice	Plastic	5 g

TABLE 3

HOLDING TIMES, PRESERVATION METHODS, AND SAMPLE CONTAINERS FOR BIOTA SAMPLES
(continued)

	Holding Time From Date Collected	Preservation Method	Container	Approximate Sample Size*
SAMPLES FOR RADIONUCLIDE ANALYSES				
Terrestrial Vegetation				
- Uranium 223, 234, 235, 238 Americium 241 Plutonium 239, 240	6 mos.	Freeze & ship w/dry ice	Paper bag inserted into plastic bag and sealed	1 kg
Periphyton and Benthic Macroinvertebrates				
- Uranium 233, 234, 245, 238 Americium 241 Plutonium 239, 240	6 mos.	Freeze & ship w/dry ice	Plastic	1 kg

* Sample size may vary with specific laboratory requirements.

**ICP = Inductively Coupled Argon Plasma Emission Spectroscopy. Metals to be determined include Ba, Cr, Cu, and Fe.

***GFAA = Graphite Furnace Atomic Absorption Spectroscopy. Metals to be determined include As, Cd, Li, Pb, Se, and Sr.

specified in SOP 4.2 (see Table 1). Measurements shall be made using the following equipment (or EG&G-approved alternates):

- Temperature: mercury-filled, teflon-coated safety type thermometer (VWR catalogue no. 6107-823 or equivalent) or digital readout thermistor
- Specific Conductivity: HACH 44600 Conductivity/TDS Meter
- Dissolved Oxygen: HACH or YSI model 57 Dissolved Oxygen Meter
- Ph: HACH One Ph Meter (this meter may also be used for temperature measurements)
- Chlorine and Turbidity: HACH DR 2000 spectrophotometer
- Alkalinity: HACH digital titrator

In addition to the field measurements for water quality, field measurements for radiation, soil gas, and VOCs in ground water will also be made. The following instruments will be used for these measurements.

- Radiological field readings for field survey grid locations and drill cuttings, core, and samples: A side-shielded field instrument for detection of low energy radiation (FIDLER), Ludlum Model 12-1A or equivalent. Use, calibration, and maintenance according to SOP 1.16, Field Radiological Measurements.
- Field readings for soil gas and VOCs in groundwater: A portable photoionization detector (PID), HNU Systems P1-101 or equivalent. Use, calibration, and maintenance according to SOP 1.15, Photoionization Detectors (PIDs) and Flame Ionization Detectors (FIDs).

Each piece of field equipment shall have a file that contains:

- Specific model and instrument serial number;
- Operating instructions;
- Routine preventative maintenance procedures, including a list of critical spare parts to be provided or available in the field;
- Calibration methods, frequency, and description of the calibration solutions; and
- Standardization procedures (traceability to nationally recognized standards).

The above information shall, in general, conform to the manufacturer's recommended operating instructions or shall explain the deviation from said instructions.

12.2 Laboratory Equipment

Laboratory analyses will be performed by contracted laboratories in accordance with the analytical protocols specified in the GRRASP. The equipment used to analyze environmental samples shall be calibrated, maintained, and controlled in accordance with the requirements contained in the specific analytical protocols used.

13.0 HANDLING, STORAGE, AND SHIPPING

Samples shall be packaged, transported, and stored in accordance with SOP 1.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Maximum sample holding times, sample preservative, sample volumes, and sample containers are specified in Table 8-1 of Section No. 8.0 of the QAPjP.

The EG&G Environmental Monitoring and Assessment Division will develop and implement an SOP for handling and storing construction materials to ensure only appropriate, accepted materials are used and are handled and stored to prevent contamination or damage prior to use/installation.

14.0 STATUS OF INSPECTION, TEST, AND OPERATIONS

The requirements for the identification of inspection, test, and operating status shall be implemented as specified in Section No. 14.0 of the QAPjP. A log specifying the status of all boreholes and groundwater monitoring wells shall be maintained by EMAD. The log will include: well/borehole identification number, ground elevation, casing depth of hole, depth to bedrock, static water level (as applicable), depth to top and bottom of screen (as applicable), diameter of hole, diameter of casing, and top/bottom of casing.

15.0 CONTROL OF NONCONFORMANCES

The requirements for the identification, control, evaluation, and disposition of nonconforming items, samples, and data will be implemented as specified in Section No. 15.0 of the QAPjP. Nonconformances identified by the implementing contractor(s) shall be submitted to EG&G for processing as outlined in the QAPjP.

16.0 CORRECTIVE ACTION

The requirements for the identification, documentation, and verification of corrective actions for conditions adverse to quality will be implemented as outlined in Section No. 16.0 of the QAPjP. Conditions adverse to quality identified by the implementing contractor shall be documented and submitted to EG&G for processing as outlined in the QAPjP.

17.0 QUALITY ASSURANCE RECORDS

QA records will be processed in accordance with the SOP 1.2, Field Document Control. QA records to be generated during OU-5 RFI/RI activities include, but are not limited to:

- Field Logs (e.g., sample collection notebooks/logs for water, sediment, and air)
- Calibration Records
- Sample Collection & Chain-of-Custody Records
- Drilling Logs
- Work Plan/Field Sampling Plan
- QAPjP/QAA
- Audit/Surveillance/Inspection Reports
- Nonconformance Reports
- Corrective Action Documentation

- Data Validation Results
- Analytical Results
- Procurement/Contracting Documentation
- Training/Qualification Records
- Inspection Records

18.0 QUALITY VERIFICATION

The requirements for the verification of quality shall be implemented as specified in Section No. 18.0 of the QAPjP. Audits of contractors providing field investigation, construction, and analytical support services shall be performed at least annually or once during the life of the project, whichever is more frequent.

19.0 SOFTWARE CONTROL

The requirements for the control of software shall be implemented as specified in Section 19.0 of the QAPjP. Only database software is anticipated to be used for the OU-5 Workplan activities. SOPs applicable to the use of the database storing environmental data are SOP 1.14, Field Data Management.

APPENDIX A

Analytical Methods, Detection Limits, and Data Quality Objectives

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	SW	GW	SOIL	SED	Required Detection Limits Water	Required Detection Limits Soil/Sed.	Precision Objective	Accuracy Objective
INDICATORS									
Total Suspended Solids	EPA 160.2[d]	X^U				10 mg/L	NA	20%RPD[f]	80-120% LCS Recovery
Total Dissolved Solids	EPA 160.1[d]	X^F	X^F			5 mg/L	NA	20%RPD[f]	80-120% LCS Recovery
pH	EPA 150.1[d]	X^U	X^F			0.1 Ph units	0.1 Ph units	NA	±0.05 Ph units
INORGANICS									
Target Analyte List - Metals		X^F	X^F	X	X			WATER/SOIL	WATER/SOIL
Aluminum	EPA CLP SOW[a]					200 ug/L[4]	40 mg/Kg[4]	**	***
Antimony	EPA CLP SOW[a]					60	12		
Arsenic (GFAA)	EPA CLP SOW[a]					10	2		
Barium	EPA CLP SOW[a]					200	40		
Beryllium	EPA CLP SOW[a]					5	1.0		
Cadmium	EPA CLP SOW[a]					5	1.0		
Calcium	EPA CLP SOW[a]					5000	2000		
Chromium	EPA CLP SOW[a]					10	2.0		
Cobalt	EPA CLP SOW[a]					50	10		
Copper	EPA CLP SOW[a]					25	5.0		
Cyanide	EPA 335.3 (modified for CLP)[a,d]					5	10		
Iron	EPA CLP SOW[a]					100 ug/L[4]	20 mg/Kg[4]		
Lead (GFAA)	EPA CLP SOW[a]					3	1.0		
Magnesium	EPA CLP SOW[a]					5000	2000		
Manganese	EPA CLP SOW[a]					15	3.0		
Mercury (CVAA)	EPA CLP SOW[a]					0.2	0.2		
Nickel	EPA CLP SOW[a]					40	8.0		
Potassium	EPA CLP SOW[a]					5000	2000		
Selenium (GFAA)	EPA CLP SOW[a]					5	1.0		
Silver	EPA CLP SOW[a]					10	2.0		
Sodium	EPA CLP SOW[a]					5000	2000		
Thallium (GFAA)	EPA CLP SOW[a]					10	2.0		
Vanadium	EPA CLP SOW[a]					50	10		
Zinc	EPA CLP SOW[a]					20	4.0		

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	SW	GW	SOIL	SED	Required Detection Limits Water	Required Detection Limits Soil/Sed.	Precision Objective	Accuracy Objective
Other Metals		X^U	X^F	X	X			WATER/SOIL	WATER/SOIL
Molybdenum	EPA CLP SOW[b] (ICAP)					8 ug/L[4]	40 mg/Kg[4]	**	***
Cesium	EPA CLP SOW[b]					1000	200		
Strontium	EPA CLP SOW[b]					200	40		
Lithium	EPA CLP SOW[b]					100	20		
Tin	EPA CLP SOW[b]					200	40		
Other Inorganics								WATER/SOIL	WATER/SOIL
Percent Solids	EPA 160.3[d]			X	X	NA	10 mg/kg	NA	NA
Sulfide	EPA 376.1[d]			X	X	NA	4 ug	Same as metals	Same as metals
TOTAL ORGANIC CARBON	EPA 9060[e]	X^U	X^U	X	X	1 mg/L	1 mg/L	**	***
ANIONS								WATER/SOIL	WATER/SOIL
Carbonate	EPA 310.1[d]	X^U	X^U			10 mg/L	NA	Same as metals	Same as metals
Bicarbonate	EPA 310.1[d]	X^U	X^U			10 mg/L	NA		
Chloride	EPA 325.2[d]	X^U	X^U			5 mg/L	NA		
Sulfate	EPA 375.4[d]	X^U	X^U			5 mg/L	NA		
Nitrate as N	EPA 353.2[d] or 353.3[d]	X^U	X^U			1 mg/L	NA		
Fluoride	EPA 340.2[d]	X^U	X^U			5 mg/L	NA		
Oil and Grease	EPA 413.2[d]	X^U				5 mg/L	NA	**	***
Target Compound List - Volatiles	EPA CLP SOW[c]	X^U	X^U	X	X			WATER/SOIL	WATER/SOIL
Chloromethane	EPA CLP SOW[c]					10 ug/L	10 ug/Kg (low)[3]	**	***
Bromomethane	EPA CLP SOW[c]					10	10		
Vinyl Chloride	EPA CLP SOW[c]					10	10		
Chloroethane	EPA CLP SOW[c]					10	10		
Methylene Chloride	EPA CLP SOW[c]					5	5		

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	SW	GW	SOIL	SED	Required Detection Limits Water	Required Detection Limits Soil/Sed.	Precision Objective	Accuracy Objective
Target Compound List - Volatiles (continued)		X[U]	X[U]	X	X			WATER/SOIL	WATER/SOIL
Acetone	EPA CLP SOW[c]					10 ug/L	10 ug/Kg(low)[3]	**	***
Carbon Disulfide	EPA CLP SOW[c]					5	5		
1,1-Dichloroethene	EPA CLP SOW[c]					5	5		
1,1-Dichororethane	EPA CLP SOW[c]					5	5		
total 1,2-Dichloroethene	EPA CLP SOW[c]					5	5		
Chloroform	EPA CLP SOW[c]					5	5		
1,2-Dichloroethane	EPA CLP SOW[c]					1	5		
2-Butanone	EPA CLP SOW[c]					10	10		
1,1,1-Trichoroethane	EPA CLP SOW[c]					5	5		
Carbon Tetrachloride	EPA CLP SOW[c]					5	5		
Vinyl Acetate	EPA CLP SOW[c]					10	10		
Bromodichloromethane	EPA CLP SOW[c]					5	5		
1,2-Dichloropropane	EPA CLP SOW[c]					5	5		
cis-1,3-Dichloropropene	EPA CLP SOW[c]					5	5		
Trichloroethene	EPA CLP SOW[c]					5	5		
Dibromochloromethane	EPA CLP SOW[c]					5	5		
1,1,2-Trichloroethane	EPA CLP SOW[c]					5	5		
Benzene	EPA CLP SOW[c]					5	5		
trans-1,3-dichloropropene	EPA CLP SOW[c]					5	5		
Bromoform	EPA CLP SOW[c]					5	5		
4-Methyl-2-pentanone	EPA CLP SOW[c]					10	10		
2-Hexanone	EPA CLP SOW[c]					10	10		
Tetrachloroethene	EPA CLP SOW[c]					5	5		
Toluene	EPA CLP SOW[c]					5	5		
1,1,2,2-Tetrachoroethane	EPA CLP SOW[c]					5	5		
Chlorobenzene	EPA CLP SOW[c]					5	5		
Ethyl Benzene	EPA CLP SOW[c]					5	5		
Styrene	EPA CLP SOW[c]					5	5		
Total Xylenes	EPA CLP SOW[c]					5	5		
Target Compound List - Semi-Volatiles			X[U]	X	X			WATER/SOIL	WATER/SOIL
Phenol	EPA CLP SOW[c]					10 ug/L	330 ug/Kg[3]	**	***
bis(2-Chloroethyl)ether	EPA CLP SOW[c]					10	330		

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	SW	GW	SOIL	SED	Required Detection Limits Water	Required Detection Limits Soil/Sed.	Precision Objective	Accuracy Objective
Target Compound List - Semi-Volatiles (continued)			X[U]	X	X			WATER/SOIL	WATER/SOIL
2-Chlorophenol	EPA CLP SOW[c]					10ug/L	330ug/Kg[3]	**	***
1,3-Dichlorobenzene	EPA CLP SOW[c]					10	330		
1,4-Dichlorobenzene	EPA CLP SOW[c]					10	330		
Benzyl Alcohol	EPA CLP SOW[c]					10	330		
1,2-Dichlorobenzene	EPA CLP SOW[c]					10	330		
2-Methylphenol	EPA CLP SOW[c]					10	330		
bis(2-Chloroisopropyl)ether	EPA CLP SOW[c]					10	330		
4-Methylphenol	EPA CLP SOW[c]					10	330		
n-nitroso-di-n-propylamine	EPA CLP SOW[c]					10	330		
Hexachloroethane	EPA CLP SOW[c]					10	330		
Nitrobenzene	EPA CLP SOW[c]					10	330		
Isophorone	EPA CLP SOW[c]					10	330		
2-Nitrophenol	EPA CLP SOW[c]					10	330		
2,4-Dimethylphenol	EPA CLP SOW[c]					10	330		
Benzoic Acid	EPA CLP SOW[c]					50	1600		
bis(2-Choroethoxy)methane	EPA CLP SOW[c]					10	330		
2,4-Dichlorophenol	EPA CLP SOW[c]					10	330		
1,2,4-Trichlorobenzene	EPA CLP SOW[c]					10	330		
Naphthalene	EPA CLP SOW[c]					10	330		
4-Chloroanaline	EPA CLP SOW[c]					10	330		
Hexachlorobutadiene	EPA CLP SOW[c]					10	330		
4-Chloro-3-methylphenol	EPA CLP SOW[c]					10	330		
2-Methylnaphthalene	EPA CLP SOW[c]					10	330		
Hexachlorocyclopentadiene	EPA CLP SOW[c]					10	330		
2,4,6-Trichlorophenol	EPA CLP SOW[c]					10	330		
2,4,5-Trichlorophenol	EPA CLP SOW[c]					50	1600		
2-Chloronaphthalene	EPA CLP SOW[c]					10	330		
2-Nitroanaline	EPA CLP SOW[c]					50	1600		
Dimethylphthalate	EPA CLP SOW[c]					10	330		
Acenaphthylene	EPA CLP SOW[c]					10	330		
2,6-Dinitrotoluene	EPA CLP SOW[c]					10	330		
3-Nitroaniline	EPA CLP SOW[c]					50	1600		
Acenaphthene	EPA CLP SOW[c]					10	330		
2,4-Dinitrophenol	EPA CLP SOW[c]					50	1600		
4-Nitrophenol	EPA CLP SOW[c]					50	1600		

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	SW	GW	SOIL	SED	Water	Required Detection Limits Soil/Sed.	Precision Objective	Accuracy Objective
Target Compound List - Semi-Volatiles (continued)			X[U]	X	X			WATER/SOIL	WATER/SOIL
Dibenzofuran	EPA CLP SOW[c]					10 ug/L	330 ug/Kg[3]	**	***
2,4-Dinitrotoluene	EPA CLP SOW[c]					10	330		
Diethylphthalate	EPA CLP SOW[c]					10	330		
4-Chlorophenol Phenyl ether	EPA CLP SOW[c]					10	330		
Fluorene	EPA CLP SOW[c]					10	330		
4-Nitroanaline	EPA CLP SOW[c]					50	1600		
4,6-Dinitro-2-methylphenol	EPA CLP SOW[c]					50	1600		
N-nitrosodiphenylamine	EPA CLP SOW[c]					10	330		
4-Bromophenyl Phenyl ether	EPA CLP SOW[c]					10	330		
Hexachlorobenzene	EPA CLP SOW[c]					10	330		
Pentachlorophenol	EPA CLP SOW[c]					50	1600		
Phenanthrene	EPA CLP SOW[c]					10	330		
Anthracene	EPA CLP SOW[c]					10	330		
Di-n-butylphthalate	EPA CLP SOW[c]					10	330		
Fluoranthene	EPA CLP SOW[c]					10	330		
Pyrene	EPA CLP SOW[c]					10	330		
Butyl Benzylphthalate	EPA CLP SOW[c]					10	330		
3,3'-Dichlorobenzidine	EPA CLP SOW[c]					20	660		
Benzo(a)anthracene	EPA CLP SOW[c]					10	330		
Chrysene	EPA CLP SOW[c]					10	330		
bis(2-ethylhexyl)phthalate	EPA CLP SOW[c]					10	330		
Di-n-octyl Phthalate	EPA CLP SOW[c]					10	330		
Benzo(b)fluoranthene	EPA CLP SOW[c]					10	330		
Benzo(k)fluoranthene	EPA CLP SOW[c]					10	330		
Benzo(a)pyrene	EPA CLP SOW[c]					10	330		
Indeno(1,2,3-cd)pyrene	EPA CLP SOW[c]					10	330		
Dibenz(a,h)anthracene	EPA CLP SOW[c]					10	330		
Benzo(g,h,i)perylene	EPA CLP SOW[c]					10	330		

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	SW	GW	SOIL	SED	Required Detection Limits Water	Required Detection Limits Soil/Sed.	Precision Objective	Accuracy Objective
Target Compound List - Pesticides/PCBs			X^U	X	X			WATER/SOIL (%RPD)	WATER/SOIL (% Recovery)
alpha-BHC	EPA CLP SOW[c]					0.05 ug/L	8.0 ug/Kg[3]	**	***
beta-BHC	EPA CLP SOW[c]					0.05	8.0		
delta-BHC	EPA CLP SOW[c]					0.05	8.0		
gamma-BHC (Lindane)	EPA CLP SOW[c]					0.05	8.0		
Heptachlor	EPA CLP SOW[c]					0.05	8.0		
Aldrin	EPA CLP SOW[c]					0.05	8.0		
Heptachlor Epoxide	EPA CLP SOW[c]					0.05	8.0		
Endosulfan I	EPA CLP SOW[c]					0.05	8.0		
Dieldrin	EPA CLP SOW[c]					0.10	16.0		
4,4'-DDE	EPA CLP SOW[c]					0.10	16.0		
Endrin	EPA CLP SOW[c]					0.10	16.0		
Endosulfan II	EPA CLP SOW[c]					0.10	16.0		
4,4'-DDD	EPA CLP SOW[c]					0.10	16.0		
Endosulfan Sulfate	EPA CLP SOW[c]					0.10	16.0		
4,4'-DDT	EPA CLP SOW[c]					0.10	16.0		
Methoxychlor	EPA CLP SOW[c]					0.5	80.0		
Endrin Ketone	EPA CLP SOW[c]					0.10	16.0		
alpha-Chlordane	EPA CLP SOW[c]					0.5	80.0		
gamma-Chlordane	EPA CLP SOW[c]					0.5	80.0		
Toxaphene	EPA CLP SOW[c]					1.0	160.0		
AROCLOR-1016	EPA CLP SOW[c]					0.5	80.0		
AROCLOR-1221	EPA CLP SOW[c]					0.5	80.0		
AROCLOR-1232	EPA CLP SOW[c]					0.5	80.0		
AROCLOR-1242	EPA CLP SOW[c]					0.5	80.0		
AROCLOR-1248	EPA CLP SOW[c]					0.5	80.0		
AROCLOR-1254	EPA CLP SOW[c]					1.0	160.0		
AROCLOR-1260	EPA CLP SOW[c]					1.0	160.0		
RADIONUCLIDES								(Replicate Analyses)	(Laboratory Control Sample)
Gross Alpha	f,g,h,i,k,l,m,n	$X^{F,U}$	X^F	X	X	2 pCi/L	4 pCi/g	**	***
Gross Beta	f,g,h,i,k,l,m,n	$X^{F,U}$	X^F	X	X	4 pCi/L	10 pCi/g		
Uranium 233+234	f,h,i,m,n	$X^{F,U}$	X^F	X	X	0.6 pCi/L	0.3 pCi/g		
Uranium 235,238	f,h,i,m,n	$X^{F,U}$	X^F	X	X	0.6 pCi/L	0.3 pCi/g		

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	SW	GW	SOIL	SED	Readability Objective	Accuracy
Target Compound List - Radionuclides (continued)							
Americium 241	p,q	$X^{F,U}$	X^{F}	X	X	0.01 pCi/L	0.02 pCi/g
Plutonium 239+240	o,p	$X^{F,U}$	X^{F}	X	X	0.01 pCi/L	0.03 pCi/g
Tritium	f,g,h,m	X^{U}	X^{U}	X	X	400 pCi/L	400 pCi/L
Strontium 89,90	f,h,i,m			X	X	NA	1 pCi/g
Strontium 90 only	f,h,i,m	$X^{F,U}$	X^{F}			1 pCi/L	NA
Cesium 137	m	$X^{F,U}$	X^{F}	X	X	1 pCi/L	0.1 pCi/g
Radium 226	f,g,h,m[5]	$X^{F,U}$	X^{F}			0.5 pCi/L	0.5 pCi/g
Radium 228	f,g,h,m[5]	$X^{F,U}$	X^{F}			1 pCi/L	0.5 pCi/g
FIELD PARAMETERS							
pH	1	X	X			± 0.1 Ph unit	± 0.2 pH units
Specific Conductance	1	X	X			2.5 umho/cm[7] 25 umho/cm[8] 250 umho/cm[9]	± 2.5% max. error at 500, 5000, 50000 umhos/cm plus probe; ± 3.0% max error at 250, 2500, and 25000 plus probe accuracy of ± 2.0%.
Temperature	1	X	X			± 0.1°C	± 1.0°C
Dissolved Oxygen	1	X				± 0.1 mg/L	± 10%
Barometric Pressure	1						

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

** Precision objective = control limits specified in referenced method and/or Data Validation Guidelines.
*** Accuracy objective = control limits specified in referenced method (in GRRASP for radionuclides).
F = Filtered
U = Unfiltered

1. Measured in the field in accordance with instrument manufacturer's instructions. The instruments to be used are specified in Section 12.
2. Medium soil/sediment required detection limits for pesticide/PCB TCL compounds are 15 times the individual low soil/sediment required detection limit.
3. Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.
4. Higher detection limits may only be used in the following circumstance: If the sample concentration exceeds five times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the required detection limit. This is illustrated in the example below:

   For lead:

   Method in use - ICP
   Instrument Detection Limit (IDL) - 40
   Sample Concentration - 220
   Required Detection Limit (RDL) - 3

   The value of 220 may be reported even though the instrument detection limit is greater than the RDL.

   Note: The specified detection limits are based on a pure water matrix. The detection limits for samples may be considerably higher depending on the sample matrix.
5. If gross alpha > 5 pCi/L, analyze for Radium 226; if Radium 226 > 3 pCi/L, analyze for Radium 228.
6. The detection limits presented were calculated using the formula in N.R.C. Regulatory Guide 4.14, Appendix Lower Limit of Detection, pg. 21, and follow:

$$LLD = \frac{4.66\ (BKG/BKG\ DUR)^{1/2}}{(2.22)(Eff)(CR)(SR)(e\text{-}\lambda t)(Aliq)}$$

$$MDA = \frac{4.66\ (BKG/Sample\ DUR)^{1/2}}{(2.22)(Eff)(CR)(SR)e^{-\lambda t}(Aliq)}$$

Where:

LLD = Lower Limit of Detection in pCi per sample unit.
BKG = Instrument Background in counts per minute (CPM).
Eff = Counting efficiency in cpm/disintegration per minute (dpm).
CR = Fractional radiochemical yield.
SR = Fractional radiochemical yield of a known solution.
λ = The radioactive decay constant for the particular radionuclide.
t = The elapsed time between sample collection and counting.
Aliq = Sample volume.
BKG DUR = Background count duration in minutes.

MDA = Minimum Detectable Activity in pCi per sample unit
BKG = same as for LLD
Eff = same as for LLD
CR = same as for LLD
SR = same as for LLD
λ = same as for LLD
t = same as for LLD
Aliq = same as for LLD
Sample DUR = sample count duration in minutes

ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

7. On 500 umho/cm range.
8. On 5000 umho/cm range.
9. On 50000 umho/cm range.

a. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, 7/88 (or latest version).
b. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, 7/88 (or latest version). The specific method to be utilized is at the laboratory's discretion provided it meets the specified detection limit.
c. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration, 2/88 (or latest version).
d. Methods are from "Methods for Chemical Analysis of Water and Wastes," U.S. Environmental Protection Agency, 1983, unless otherwise indicated.
e. Methods are from "Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods," (SW-846, 3rd Ed.), U.S. Environmental Protection Agency.
f. U.S. Environmental Protection Agency, 1979, Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No. EMSL-LY-0539-1, Las Vegas, NV, U.S. Environmental Protection Agency.
g. American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985. Standard Methods for the Examination of Water and Wastewater, 16th ed., Washington, D.C., Am. Public Health Association.
h. U.S. Environmental Protection Agency, 1976. Interim Radiochemical Methodology for Drinking Water, Report No. EPA-600/4-75-008. Cincinnati U.S. Environmental Protection Agency.
i. Harley, J.H., ed., 1975, HASL Procedures Manual, HASL-300; Washington, D.C., U.S. Energy Research and Development Administration.
j. US EPA-600/4-82-057.
k. "Handbook of Analytical Procedures," USAEC, Grand Junction Lab. 1970, page 196.
l. "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032, August 1980, Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.
m. "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments," U.S.G.S. Book 5, Chapter A5, 1977.
n. "Acid Dissolution Method for the Analysis of Plutonium in Soil," EPA-600/7-79-081, March 1979, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979.
o. "Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium, Uranium, and Americium," by E.H. Essington and B.J. Drennon, Los Alamos National Laboratory, a private communication.
p. "Isolation of Americium from Urine Samples," Rocky Flats Plant, Health, Safety, and Environmental Laboratories.
q. "Radioactivity in Drinking Water," EPA 570/9-81-002.
r. If the sample or duplicate result is <5 x IDL, then the control limit is ± IDL.

11.0
STANDARD OPERATING PROCEDURES AND ADDENDA

The following Rocky Flats Plant (RFP) program-wide Standard Operating Procedures (SOPs) will be used during the specific field investigations for Operable Unit Number 5 (OU5):

FO.13	Containerizing, Preserving, Handling and Shipping Soil and Water Samples
FO.14	Data Base Management
FO.16	Field Radiological Measurements
GW.1	Water Level Measurements in Wells and Piezometers
GW.2	Well Development
GW.5	Measurement for Groundwater Field Parameters
GW.6	Groundwater Sampling
GT.1	Logging Alluvial and Bedrock Material
GT.2	Drilling and Sampling Using Hollow-Stem Auger Techniques
GT.6	Monitoring Well and Piezometer Installation
GT.8	Surface Soil Sampling
GT.9	Soil Gas Sampling and Field Analysis
GT.10	Borehole Clearing
SW.1	Surface Water Data Collection Activities
SW.2	Field Measurement of Surface Water Field Parameters
SW.3	Surface Water Sampling
SW.6	Sediment Sampling
SW.8	Pond Sampling
AP.13	Radioactive Ambient Air Monitoring Program

In addition, Field Operations, Volume I, SOPs will also be used, as appropriate, during field operations.

Specific information concerning sampling activities is provided in the Field Sampling Plan (FSP) (Section 7.0) for most of the sampling activities. Project-specific details for this work plan will be included in the Standard Operating Procedures Addenda (SOPAs). These SOPAs will be attached to the SOP for use during field activities.

11.1 ADDENDUM TO SOP SW.6, SEDIMENT SAMPLING

Sediment samples will be collected from five locations, each, in Ponds C-1 and C-2 and from numerous locations within Woman Creek and the South Interceptor Ditch (SID). The sediment samples from the ponds will be collected from the following locations:

- The deepest part of the pond
- Within the pond, 5 feet from the pond inlet
- Three locations selected at random within the area of the pond at the time of sampling

Sediment samples in Woman Creek will be collected within the channels in locations conducive to the collection of sediments.

The sediment samples at each location will be collected such that they represent the entire vertical column of sediment at the sampling location. Currently, the depth of sediment in the Detention Ponds is unknown. Samples will be collected at 2-foot intervals. All of the sediment samples, except the one from the deepest part of each pond, will be vertical composite samples that represent the entire sediment thickness, up to 2 feet. If the sediment depth is greater than 2 feet, 2-foot composite samples will be collected. The samples from the deepest part of each pond will be composited at 2-inch intervals, instead of 2-foot intervals.

Samples from Woman Creek will be collected according to SOP SW.6, Sediment Sampling. These samples will be collected with a core sampling device capable of obtaining a sample of the entire thickness of sediment at a given location, which can be logged. Samples for analysis of volatile or semivolatile organic compounds will be collected as grab samples and not composited.

Sediment samples from the Detention Ponds will be collected with a King tube sampler with a diameter of not more than 2 inches. Several soil cores may be needed to obtain enough samples for analyses. One of the samples will be maintained in the vertical position and frozen for subsequent geologic logging. This frozen core will be logged according to SOP GT.1, with the thickness and character of any thin stratifications in the sediment column noted. The sediment samples collected for chemical analysis will then be composited at 5-centimeter intervals. Sample handling and decontamination procedures will be followed as described in SOP SW.6, Sediment Sampling.

11.2 ADDENDUM TO SOP SW.8, POND SAMPLING

Water samples will be collected from five locations, each, in Ponds C-1 and C-2. The specific locations are as follows:

- The deepest part of the pond
- Within 5 feet of the pond inlet
- Within 5 feet of the pond spillway
- Two locations selected at random within the pond

Prior to sampling at each sampling point, profiles of water temperature and dissolved oxygen in the water column will be collected at the sampling location. The Hydrolab® Multi-Parameter Measuring Instrument will be used to collect the profiles across the entire water column.

All of the samples except the one from the deepest part of the pond will be vertical composite samples representing the entire depth of the water column at the sampling point. The sampling from the deepest part of the pond will consist of taking grab samples from each of the zones of stratification identified in the water column at that point.

11.2.1 Composited Samples

Following the measurement of temperature and dissolved oxygen at the sampling point, a sample will be collected. The sample may be collected using a regulated flow sampler (described in SOP SW.3, Surface Water Sampling), which is pulled through the entire column of water. Samples may also be collected using a peristaltic pump with the intake tubing pulled through the entire water column. VOC samples will be collected as described in SOP SW.8, Pond Sampling.

Field parameters such as pH and specific conductance will be measured in the composited sample in accordance with SOP SW.5.

11.2.2 Grab Samples

Temperature and dissolved oxygen at the sampling point in the deepest part of the pond will be measured to determine the location of stratified layers at this point. The grab samples will then be collected using a peristaltic pump in each stratified zone for all samples except VOC samples. The uppermost stratified zone will be sampled first, followed by the next lower zone, and so on. The zone at the bottom of the pond will be sampled last. VOC samples will be collected as described in SOP SW.8, Pond Sampling.

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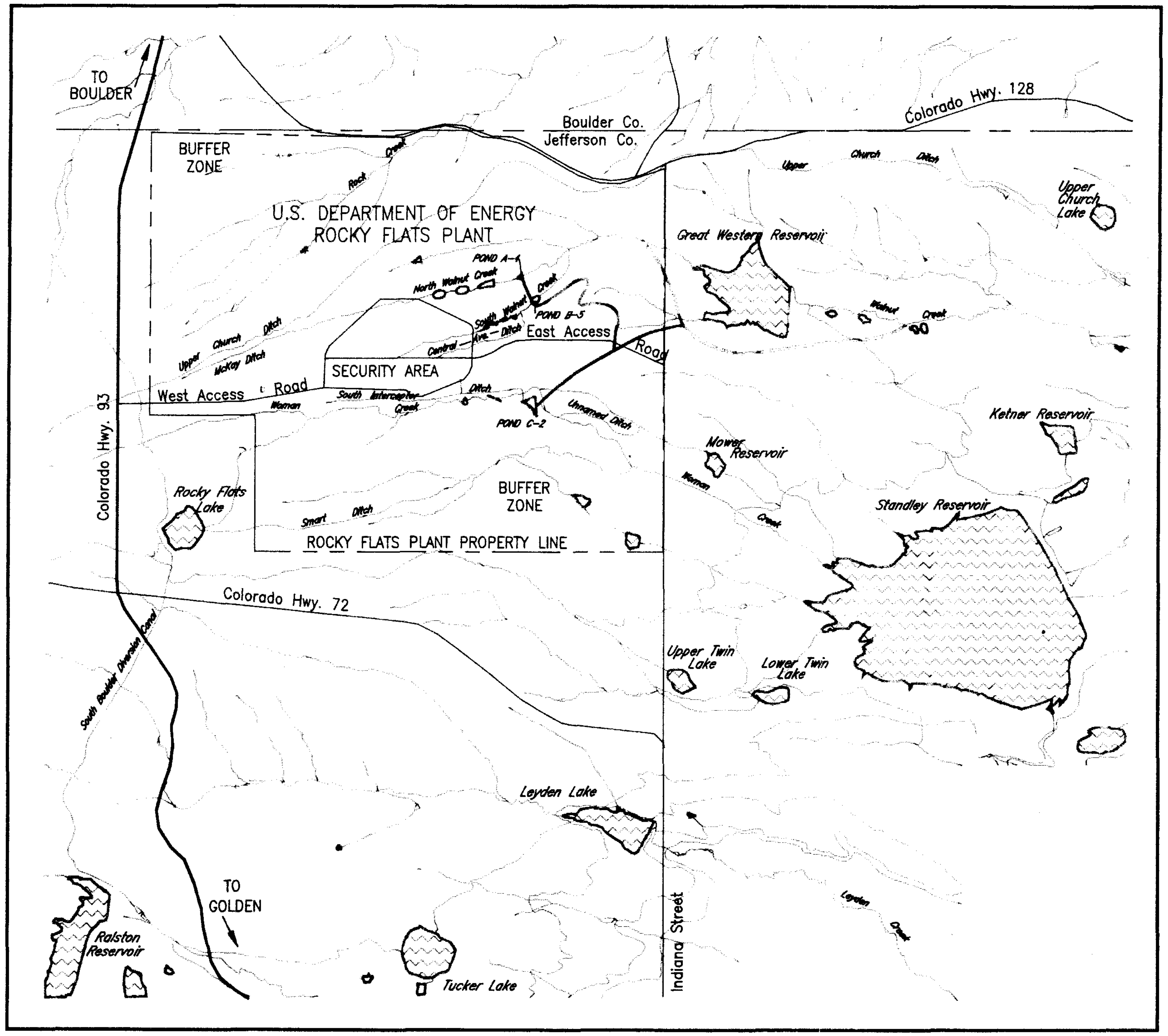


N

0 1/2 1 MILE
SCALE: 1" = 1 MILE

EXPLANATION

BROOMFIELD DIVERSION CANAL

POND C-2 DIVERSION PIPE (8" PVC)

SOURCE: EG&G 1991b

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

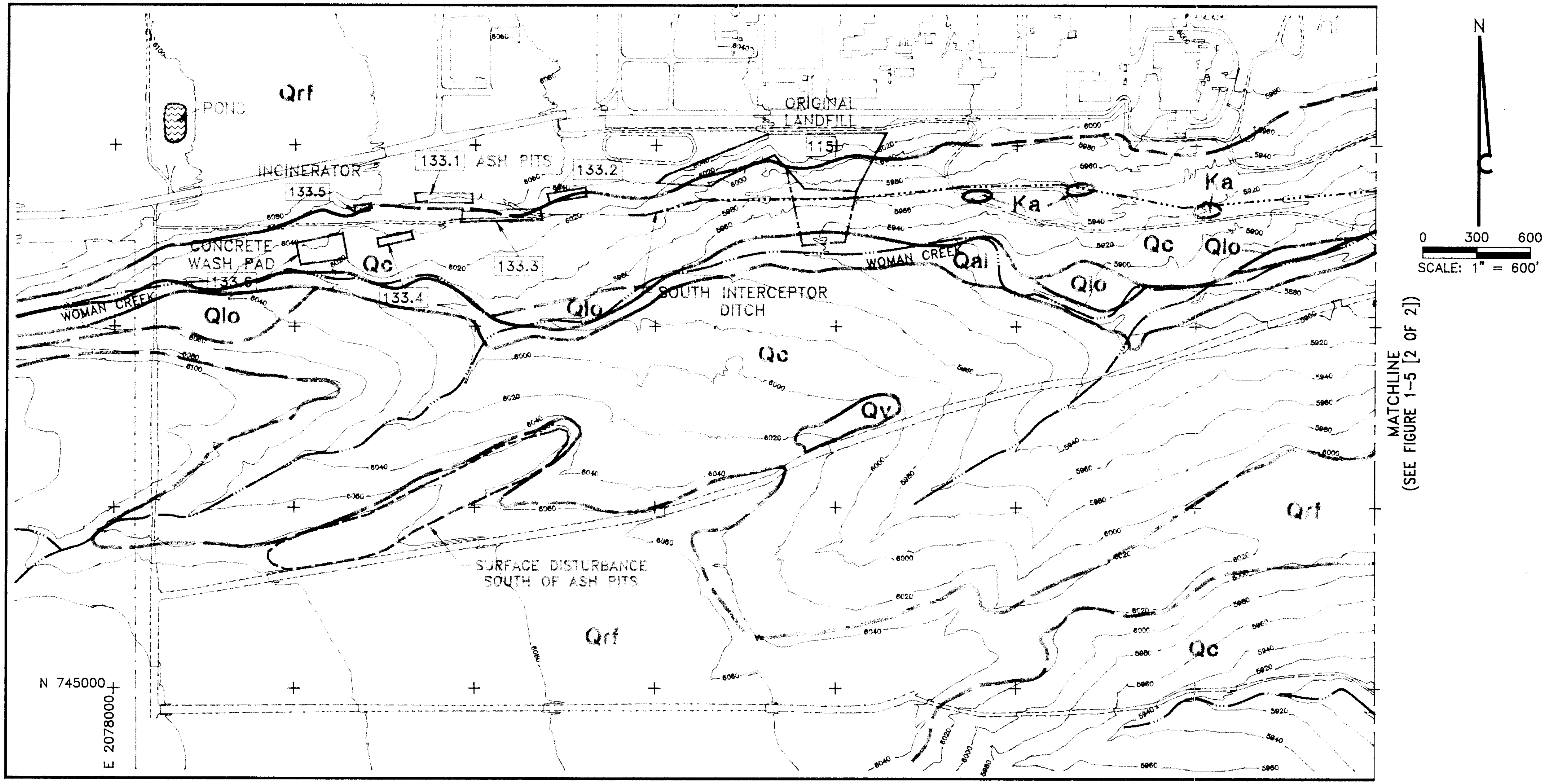
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

ROCKY FLATS PLANT
BOUNDARIES AND BUFFER ZONE

FIGURE 1-2

REV. AUGUST 1991
MARCH 1991

1-30U5



EXPLANATION

	INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 5
115	IHSS REFERENCE NUMBER
	INTERMITTENT STREAM
	DIRT ROAD
	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE

CONTACT

?—?— DASHED WHERE APPROXIMATELY LOCATED, QUERIED WHERE INFERRED.

QUATERNARY

Qal	RECENT VALLEY FILL
Ql	LANDSLIDE
Qc	COLLUVIUM
Qlo	LOUVIERS ALLUVIUM
Qs	SLOCUM ALLUVIUM
Qv	VERDOS ALLUVIUM
Qrf	ROCKY FLATS ALLUVIUM

CRETACEOUS

Kass	ARAPAHOE FORMATION, SANDSTONE
Ka	ARAPAHOE FORMATION, CLAYSTONE

SOURCE: EG&G 1990c

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

SURFICIAL GEOLOGY

FIGURE 1-5 (1 OF 2)

REV. AUGUST 1991
MARCH 1991

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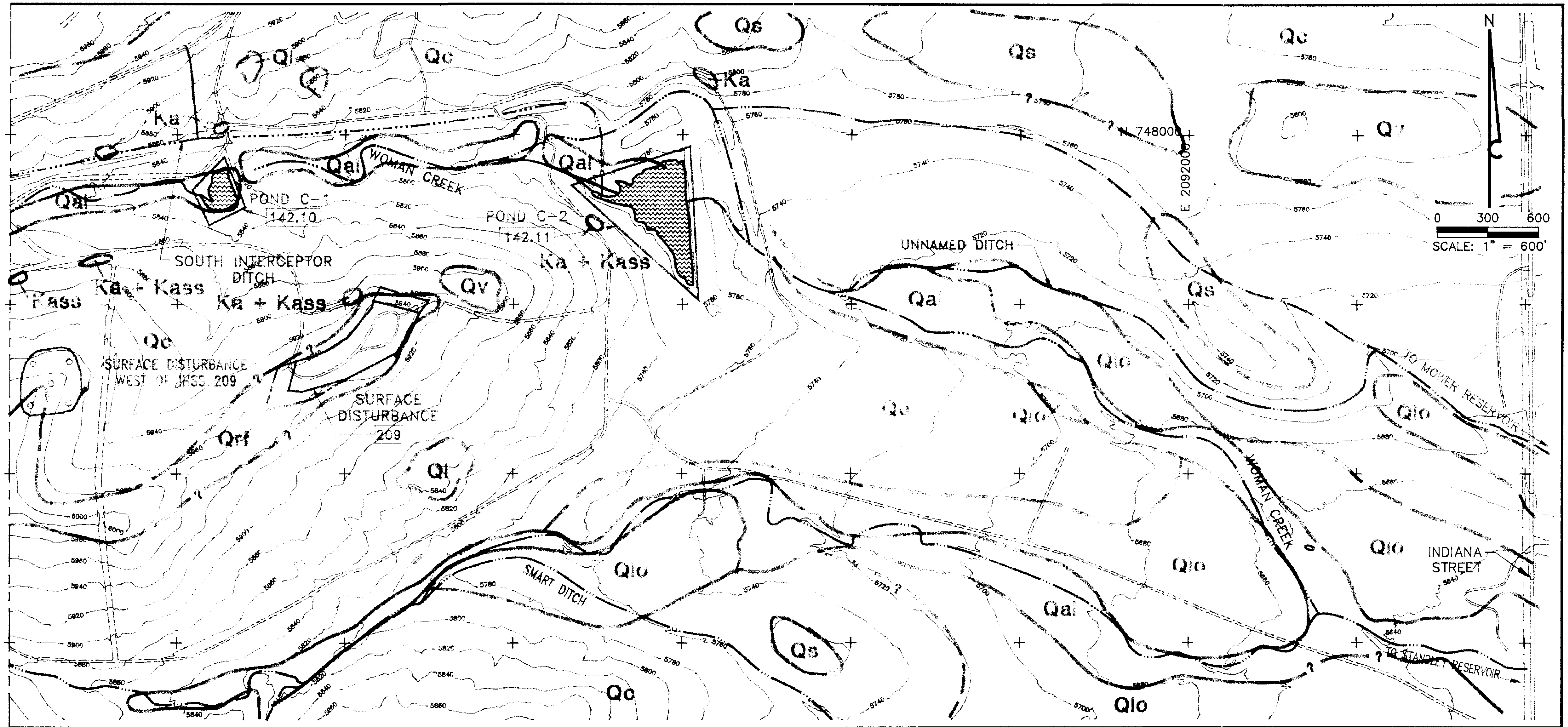

MATCHLINE
(SEE FIGURE 1-5 [1 OF 2])

EXPLANATION

	INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 5
115	IHSS REFERENCE NUMBER
	INTERMITTENT STREAM
	DIRT ROAD
	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
	ORIGINAL STREAM CHANNEL NEAR POND C-2
	CONTACT
? ?	DASHED WHERE APPROXIMATELY LOCATED, QUERIED WHERE INFERRED.

QUATERNARY

Qal	RECENT VALLEY FILL
Ql	LANDSLIDE
Qc	COLLUVIUM
Qlo	LOUVIERS ALLUVIUM
Qs	SLOCUM ALLUVIUM
Qv	VERDOS ALLUVIUM
Qrf	ROCKY FLATS ALLUVIUM

CRETACEOUS

Kass	ARAPAHOE FORMATION, SANDSTONE
Ka	ARAPAHOE FORMATION, CLAYSTONE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

SURFICIAL GEOLOGY

FIGURE 1-5 (2 of 2)

REV. AUGUST 1991
MARCH 1991

SOURCE: EG&G 1990c

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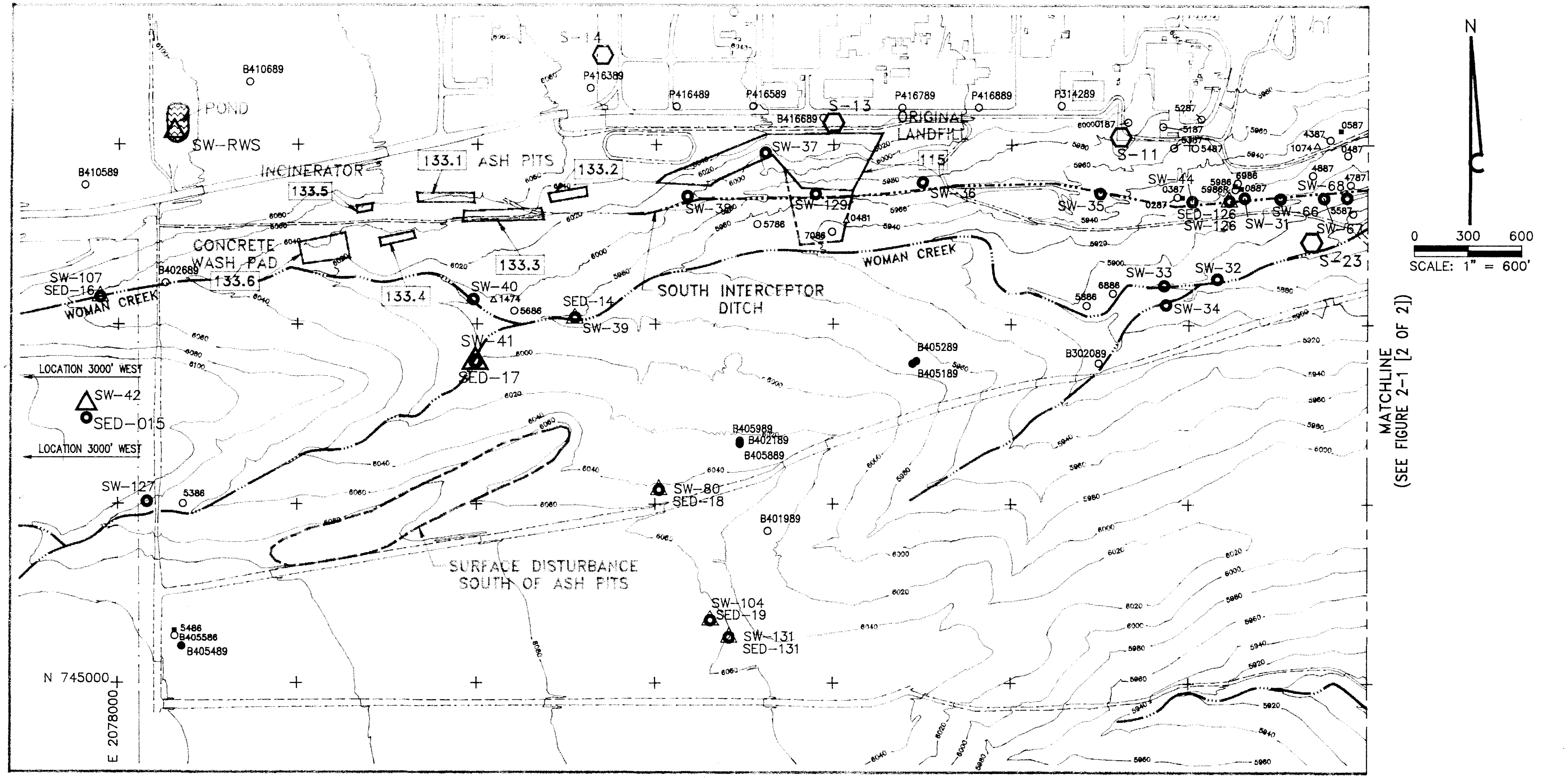


EXPLANATION

	INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 5
115	IHSS REFERENCE NUMBER
	INTERMITTENT STREAM
	DIRT ROAD
	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
S-23	EXISTING RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION
B405189	EXISTING BEDROCK GROUNDWATER MONITORING WELL
P416489	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
0481	EXISTING PRE-1986 MONITORING WELL
3087	EXISTING PRE-1988 BEDROCK GROUNDWATER MONITORING WELL
SW-126	EXISTING SURFACE WATER SAMPLING WATER LOCATION
SED-126	EXISTING SEDIMENT SAMPLING LOCATION

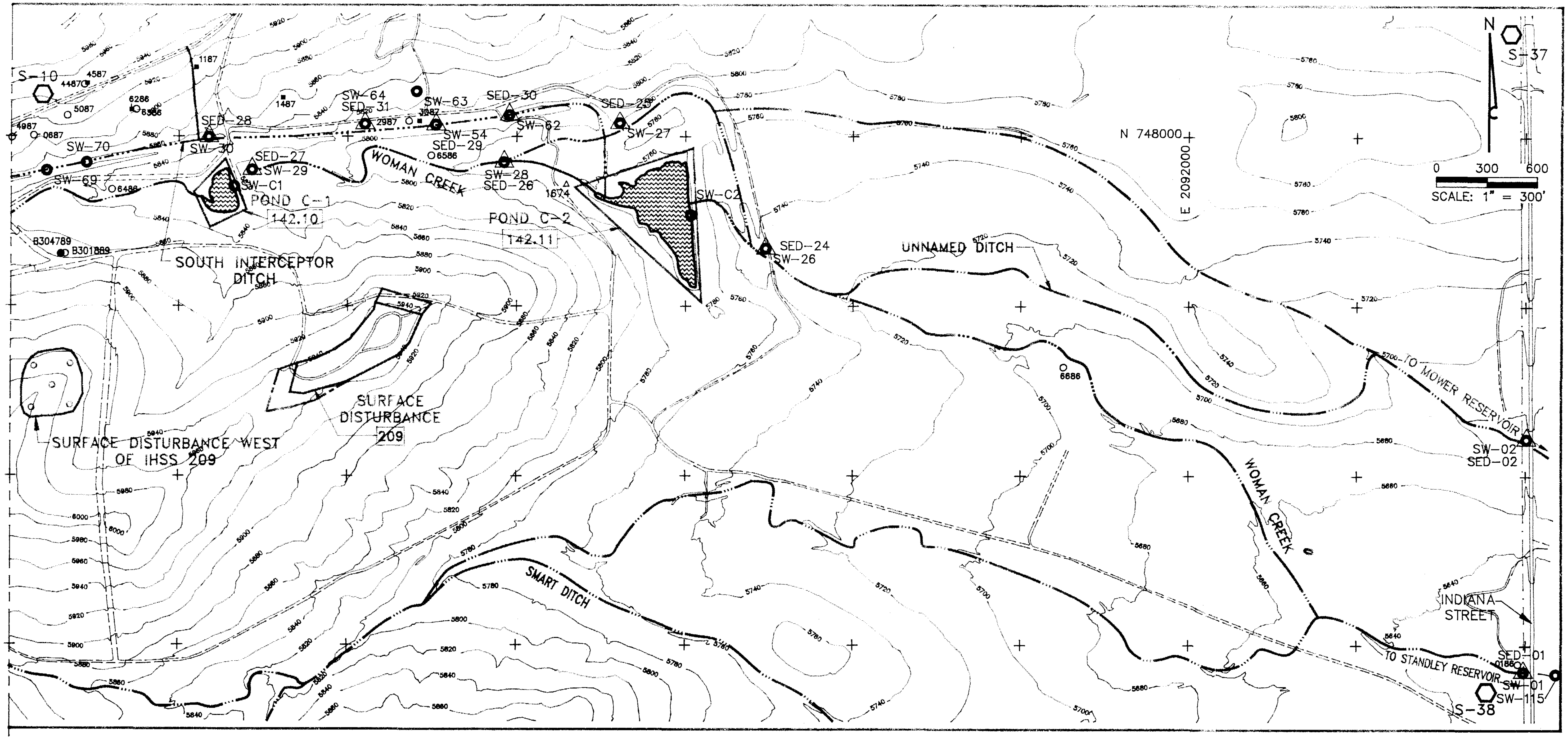
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

LOCATION MAP OF THE INDIVIDUAL HAZARDOUS SUBSTANCE SITES, SURFACE & SEDIMENT LOCATIONS, MONITORING WELLS, AND AIR MONITORING STATIONS

FIGURE 2-1 (1 OF 2)

REV. AUGUST 1991
MARCH 1991



←MATCHLINE
(SEE FIGURE 2-1[1 OF 2])

EXPLANATION

	INDIVIDUAL HAZARDOUS SUBSTANCE SITE (IHSS) IN OPERABLE UNIT 5
115	IHSS REFERENCE NUMBER
	INTERMITTENT STREAM
	DIRT ROAD
	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
	ORIGINAL STREAM CHANNEL NEAR POND C-2
B405189	EXISTING BEDROCK GROUNDWATER MONITORING WELL
P416489	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
0481	EXISTING PRE-1986 MONITORING WELL
3087	EXISTING PRE-1988 BEDROCK GROUNDWATER MONITORING WELL
SW-126	EXISTING SURFACE WATER SAMPLING WATER LOCATION
SED-126	EXISTING SEDIMENT SAMPLING LOCATION
S-23	EXISTING RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION

U.S. DEPARTMENT OF ENERGY
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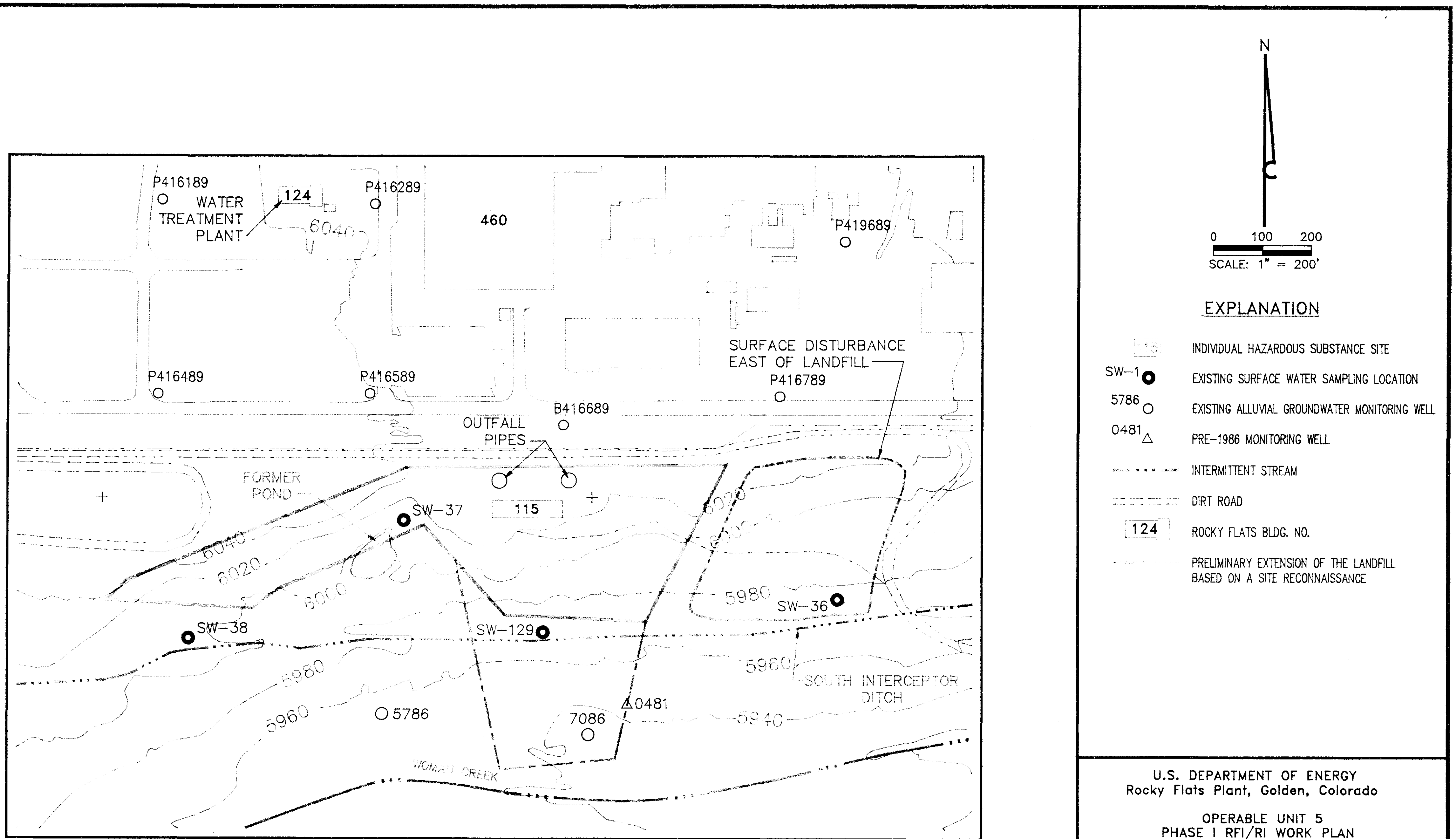
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

LOCATION MAP OF THE INDIVIDUAL HAZARDOUS SUBSTANCE SITES, SURFACE & SEDIMENT LOCATIONS, MONITORING WELLS, AND AIR MONITORING STATIONS

FIGURE 2-1 (2 OF 2) REV. AUGUST 1991 MARCH 1991

25060031



EXPLANATION

INDIVIDUAL HAZARDOUS SUBSTANCE SITE
EXISTING SURFACE WATER SAMPLING LOCATION
EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
PRE-1986 MONITORING WELL
INTERMITTENT STREAM
DIRT ROAD
ROCKY FLATS BLDG. NO.
PRELIMINARY EXTENSION OF THE LANDFILL BASED ON A SITE RECONNAISSANCE

U.S. DEPARTMENT OF ENERGY
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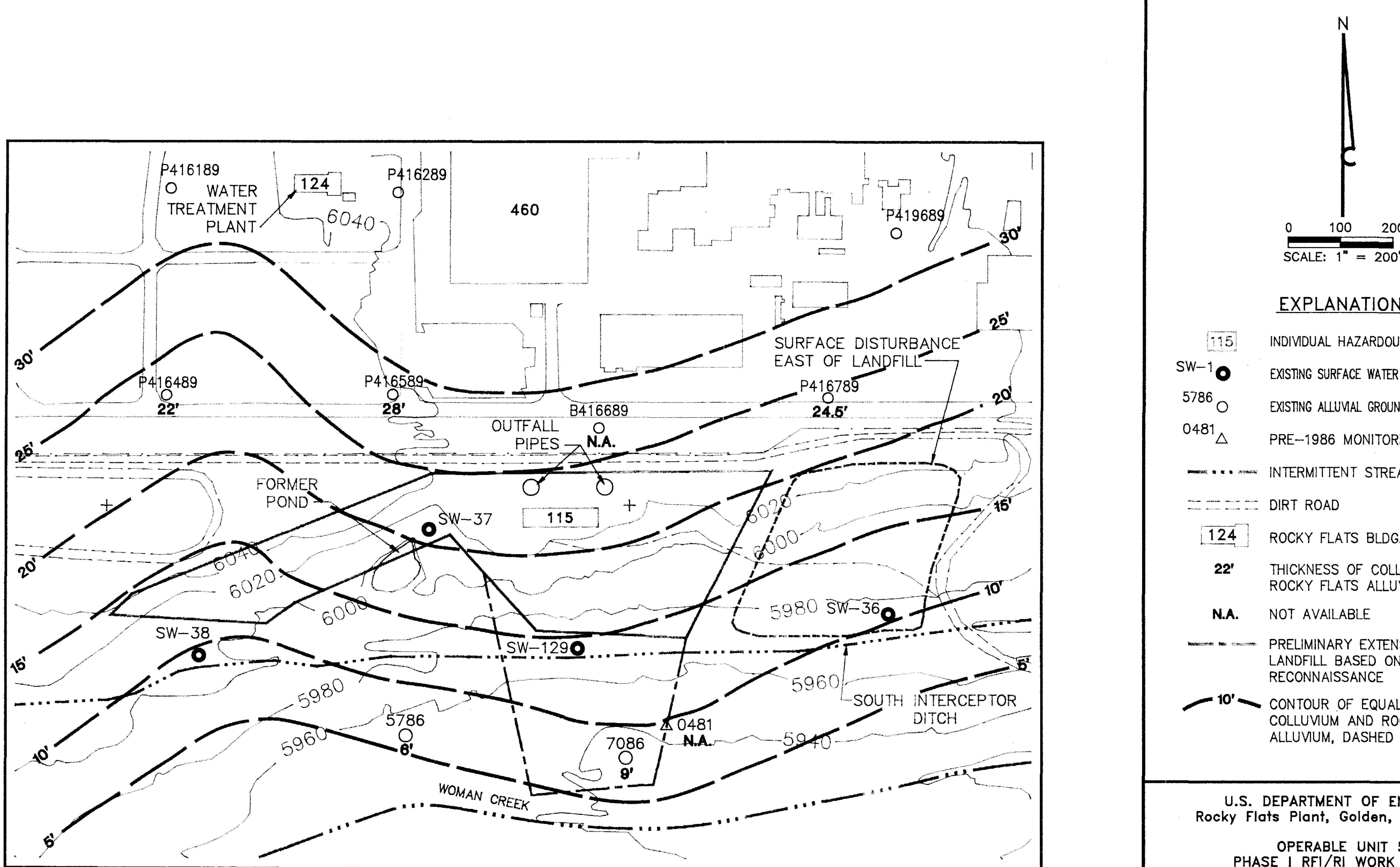
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

IHSS 115
ORIGINAL LANDFILL

FIGURE 2-2

REV. AUGUST 1991
MARCH 1991

25060032



EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER SAMPLING LOCATION
5786	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
0481	PRE-1986 MONITORING WELL
	INTERMITTENT STREAM
	DIRT ROAD
124	ROCKY FLATS BLDG. NO.
22'	THICKNESS OF COLLUVIUM AND ROCKY FLATS ALLUVIUM
N.A.	NOT AVAILABLE
	PRELIMINARY EXTENSION OF THE LANDFILL BASED ON A SITE RECONNAISSANCE
10'	CONTOUR OF EQUAL THICKNESS OF COLLUVIUM AND ROCKY FLATS ALLUVIUM, DASHED WHERE INFERRED

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Rocky Flats Plant, Golden, Colorado

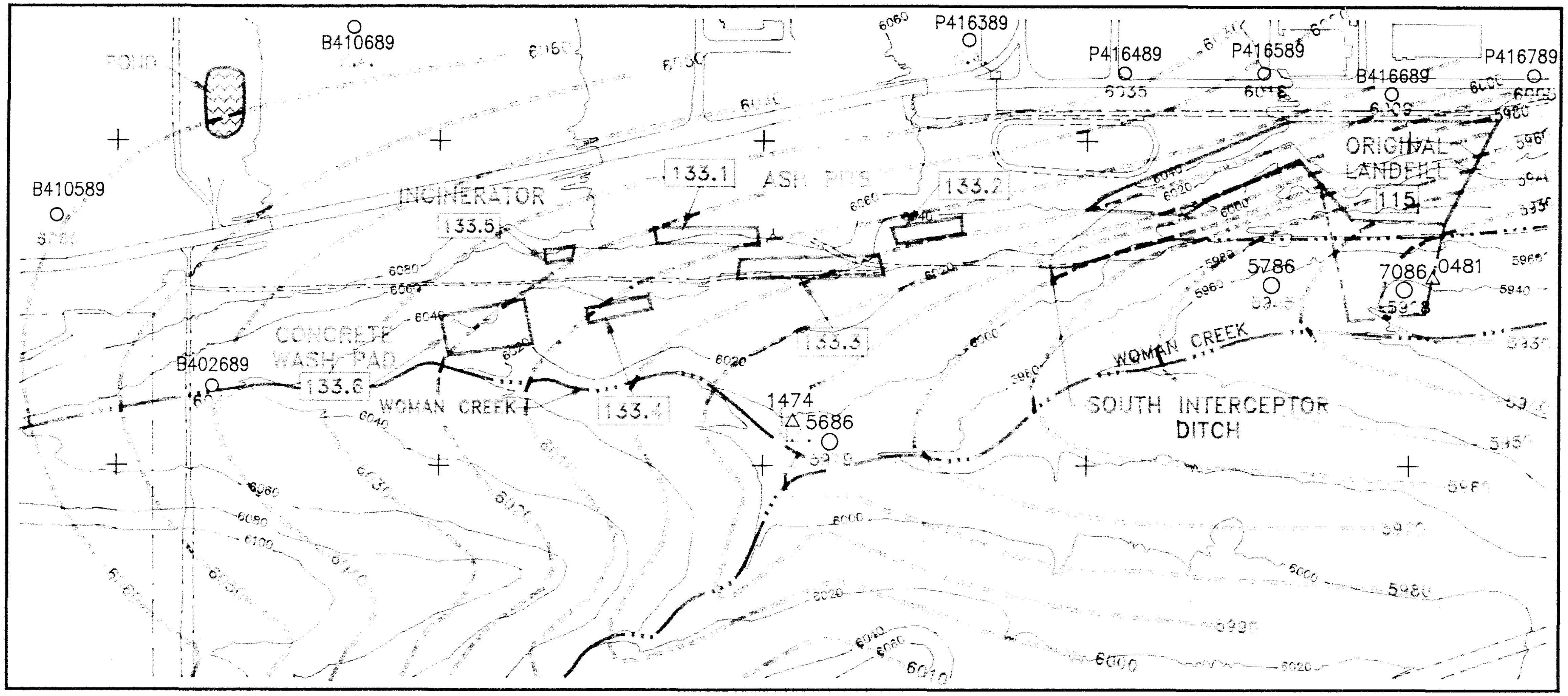
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

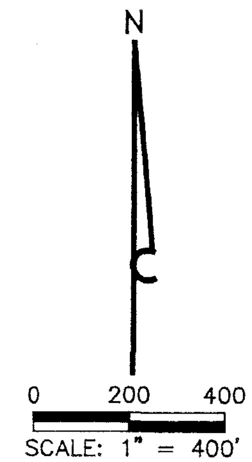
ISOPACH MAP COLLUVIUM AND ROCKY FLATS ALLUVIUM ORIGINAL LANDFILL AREA

FIGURE 2-4

REV. AUGUST 1991
MARCH 1991

25060051





EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
5786 ○	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
0481 △	PRE-1986 MONITORING WELL
5979	ELEVATION OF STATIC WATER LEVEL (OCTOBER 1990)
	INTERMITTENT STREAM
	DIRT ROAD
	PRELIMINARY EXTENSION OF THE LANDFILL BASED ON A SITE RECONNAISSANCE
10'	INFERRED CONTOUR
N.A.	NOT AVAILABLE

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Rocky Flats Plant, Golden, Colorado

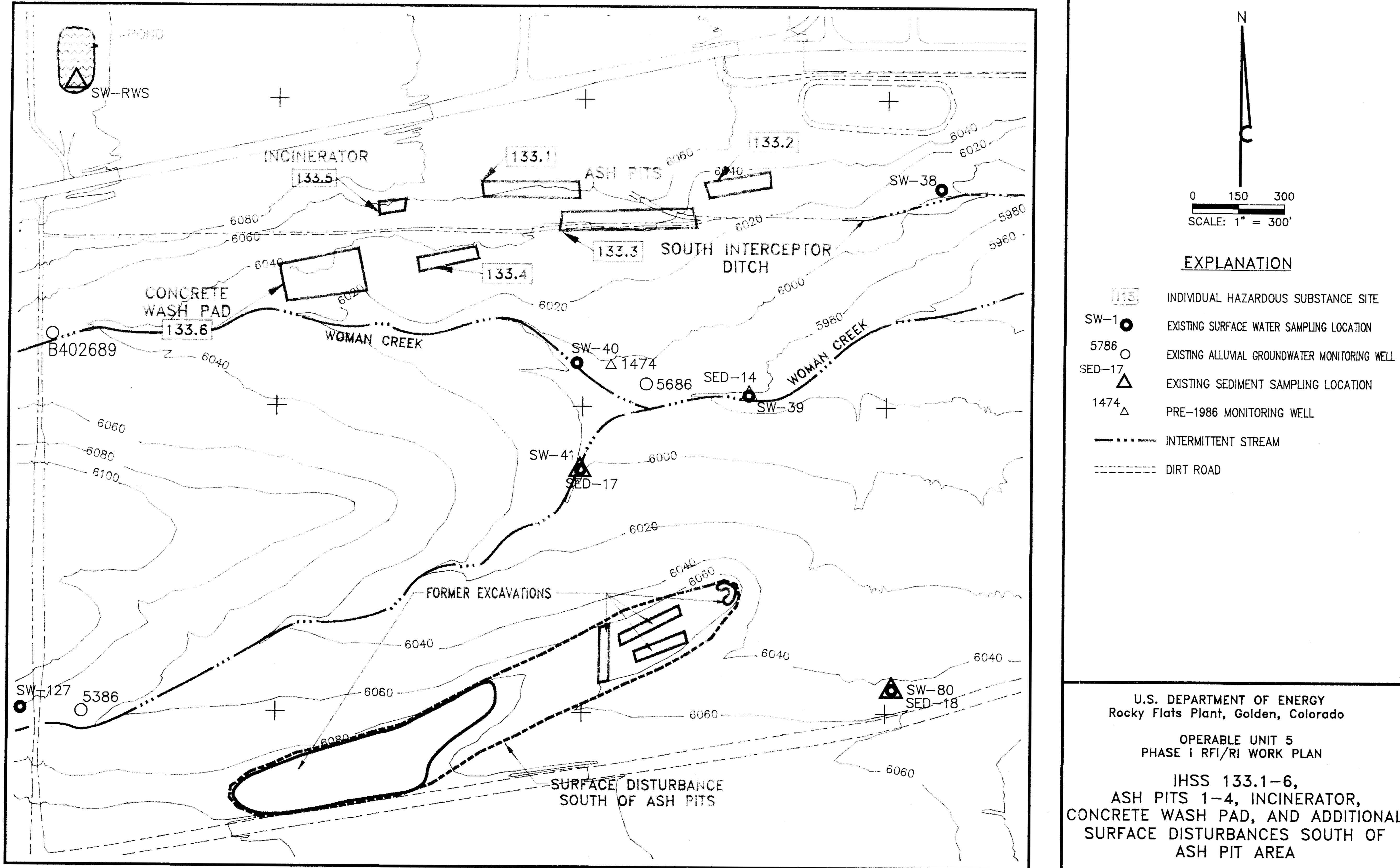
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

POTENTIOMETRIC MAP OF THE ALLUVIAL AQUIFER

FIGURE 2-5

REV. AUGUST 1991
MARCH 1991

25060061



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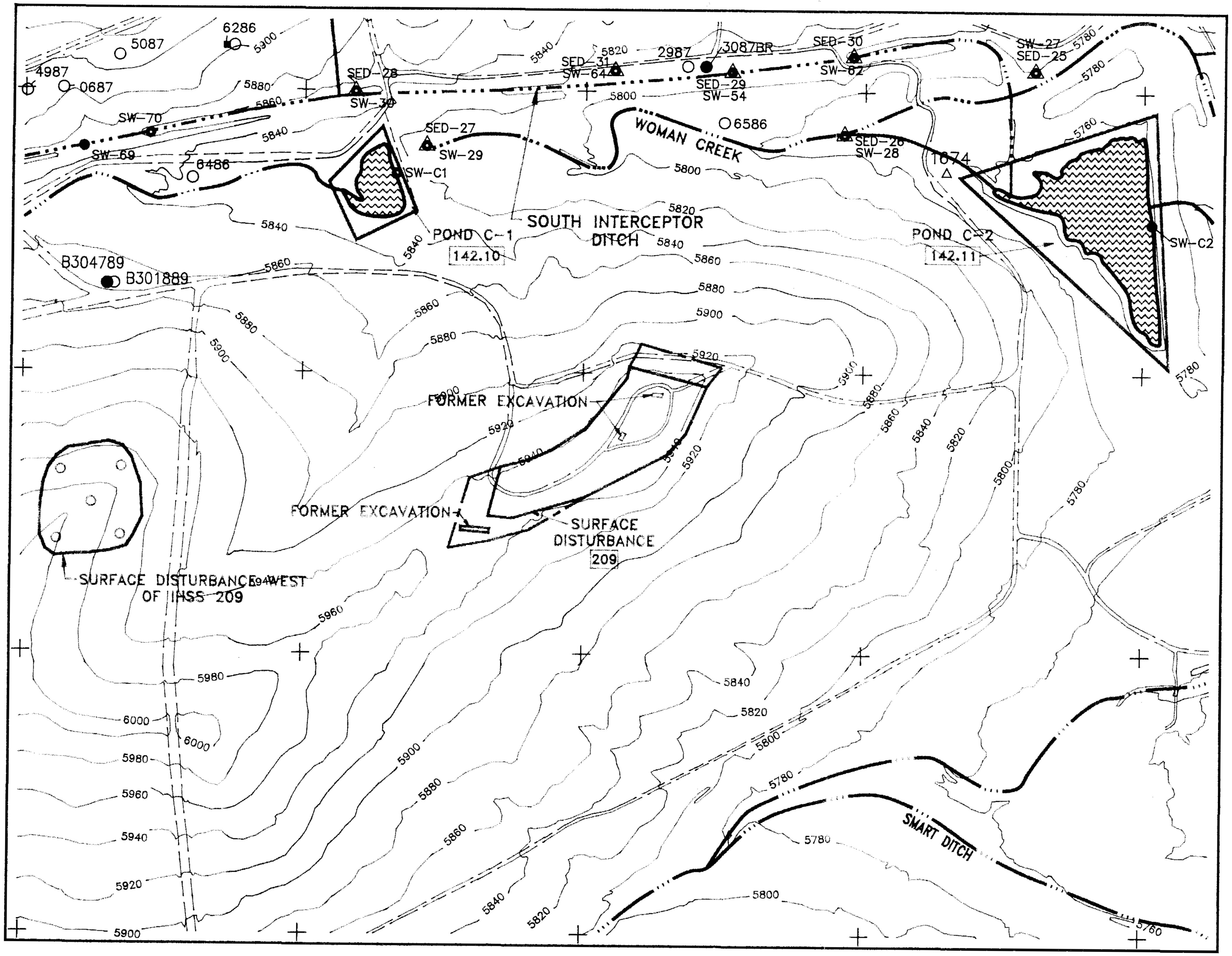
IHSS 133.1-6,
ASH PITS 1-4, INCINERATOR,
CONCRETE WASH PAD, AND ADDITIONAL
SURFACE DISTURBANCES SOUTH OF
ASH PIT AREA

FIGURE 2-6

REV. AUGUST 1991
MARCH 1991

25060071



N

0 200 400

SCALE: 1" = 400'

EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER SAMPLING LOCATION
5786	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
SED-17	EXISTING SEDIMENT SAMPLING LOCATION
3087	EXISTING BEDROCK GROUNDWATER MONITORING WELL
	PONDLIKE DEPRESSION
	INTERMITTENT STREAM
	DIRT ROAD
	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A SITE RECONNAISSANCE
	ORIGINAL STREAM CHANNEL NEAR POND C-2

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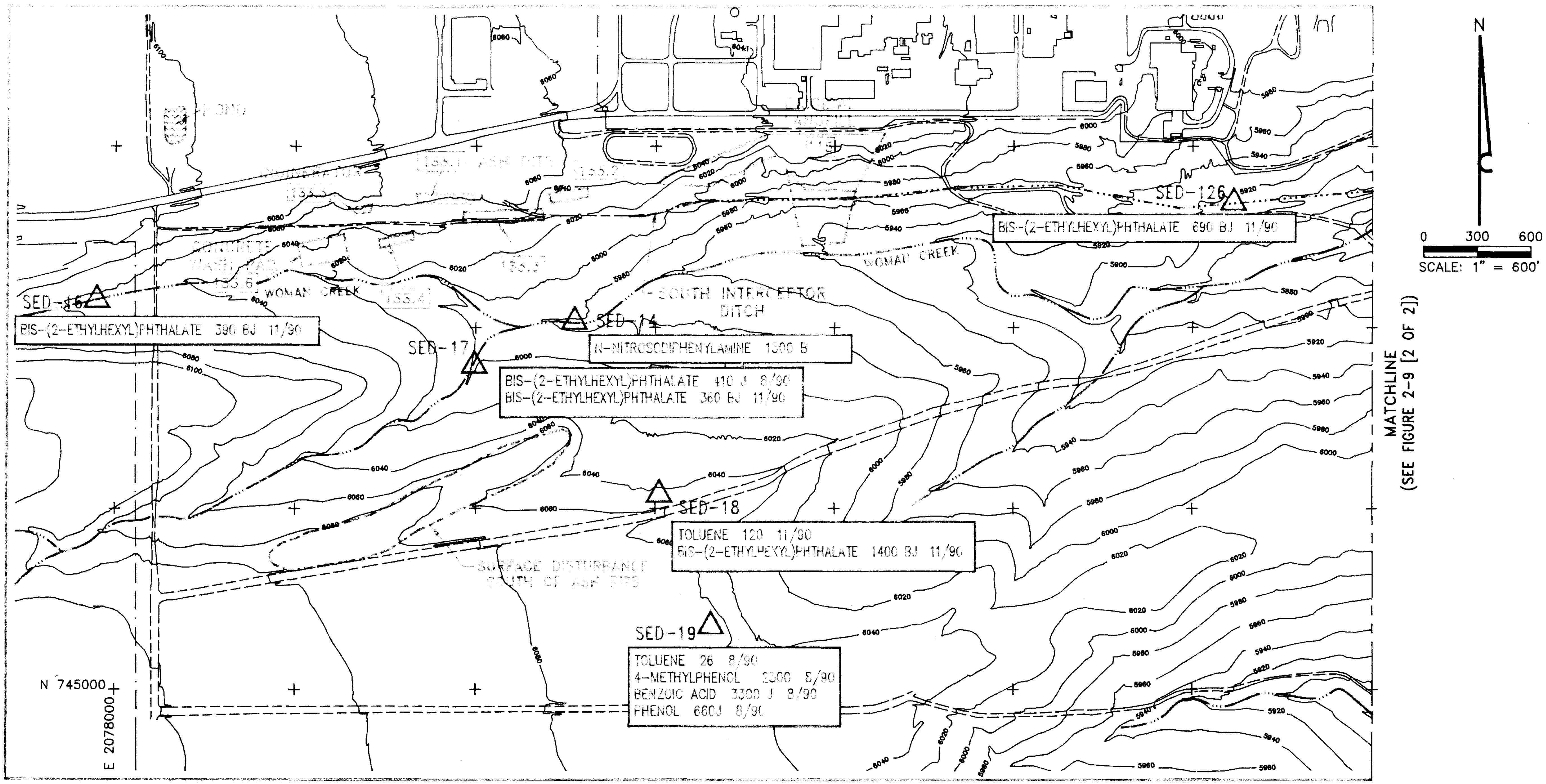
PHASE I RFI/RI WORK PLAN

C-SERIES DETENTION PONDS
(IHSS 142.10-11),
IHSS 209, AND THE SURFACE
DISTURBANCE WEST OF IHSS 209

FIGURE 2-7

REV. AUGUST 1991
MARCH 1991

25060081



EXPLANATION

- 115 INDIVIDUAL HAZARDOUS SUBSTANCE SITE
- SED-1△ EXISTING SEDIMENT SAMPLING LOCATION
- INTERMITTENT STREAM
- DIRT ROAD
- PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
- TOLUENE 120 11/90 — PARAMETER, REPORTED mg/kg, DATE OF SAMPLE

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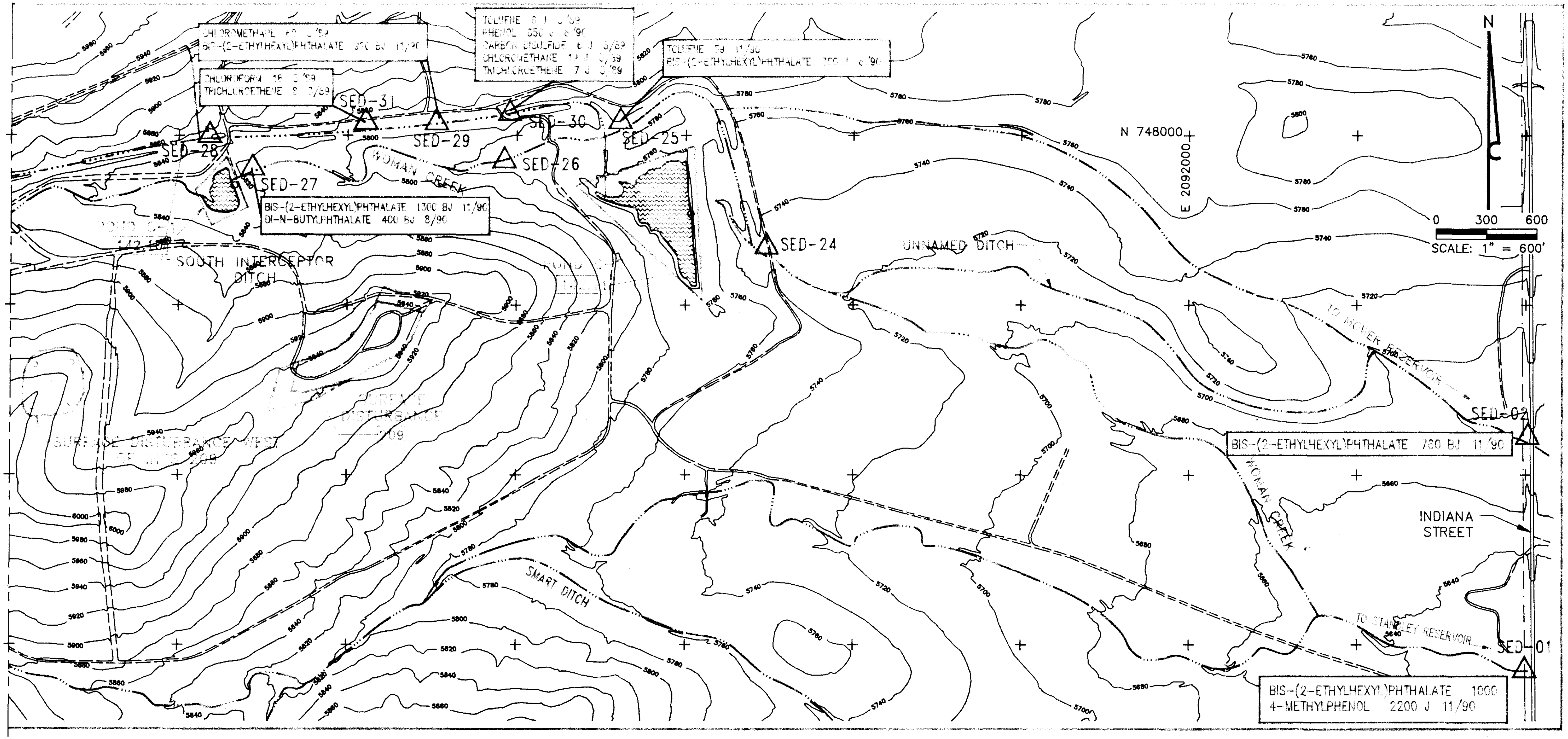
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

DETECTED ORGANIC AND PESTICIDE CONCENTRATIONS IN EXISTING SEDIMENT SAMPLES

FIGURE 2-9 (1 OF 2) AUGUST 1991

2506015A



MATCHLINE
(SEE FIGURE 2-9 [1 OF 2])

EXPLANATION

- 115 — INDIVIDUAL HAZARDOUS SUBSTANCE SITE
- SED-1△ — EXISTING SEDIMENT SAMPLING LOCATION
- INTERMITTENT STREAM
- DIRT ROAD
- PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
- TOLUENE 120 11/90 — PARAMETER, REPORTED mg/kg, DATE OF SAMPLE

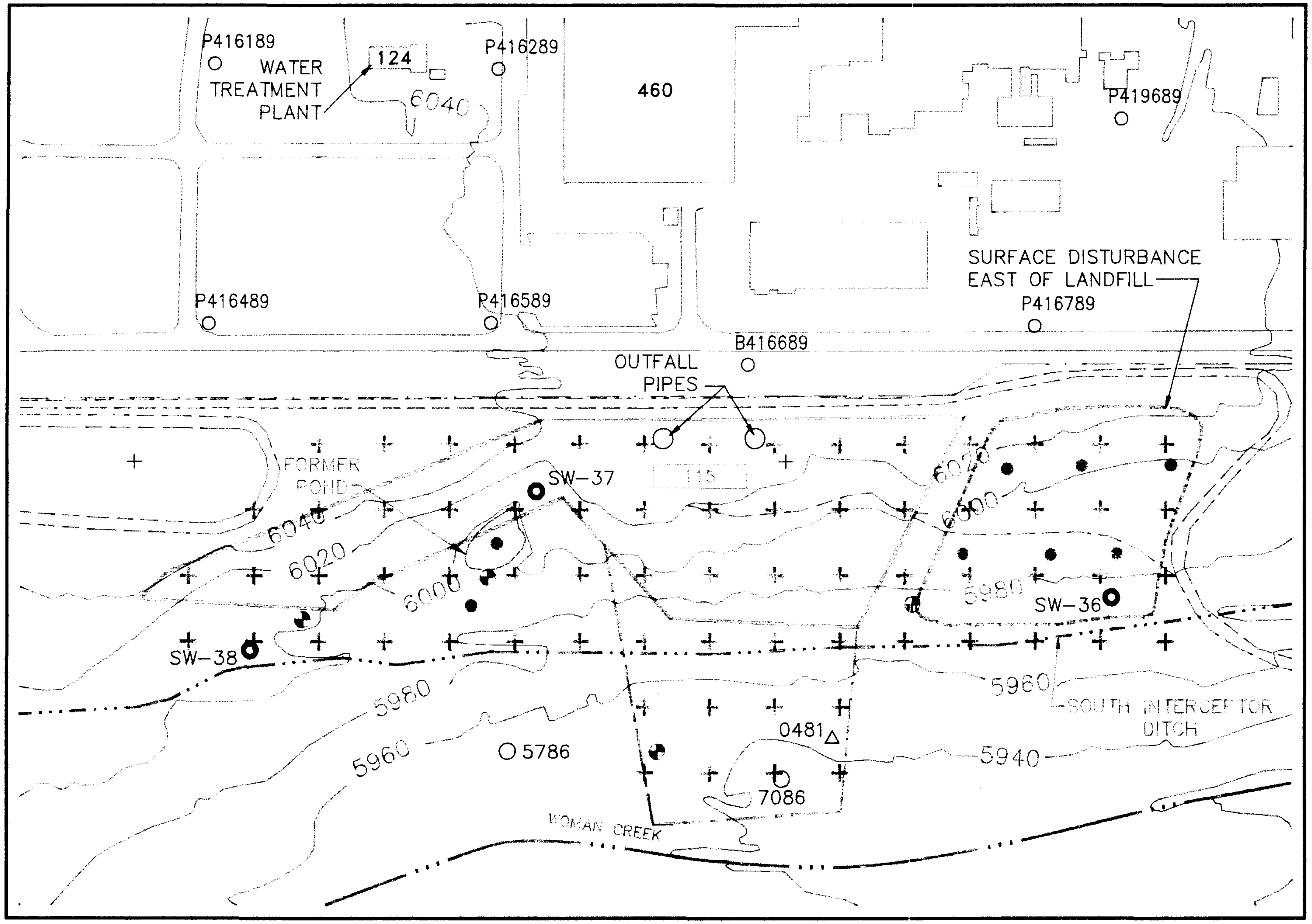
U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

DETECTED ORGANIC AND PESTICIDE CONCENTRATIONS IN EXISTING SEDIMENT SAMPLES

FIGURE 2-9 (2 OF 2) AUGUST 1991

2506015B



N

0 100 200
SCALE: 1" = 200'

EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER SAMPLING LOCATION
5786	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
0481	PRE-1986 MONITORING WELL
	INTERMITTENT STREAM
	DIRT ROAD
124	ROCKY FLATS BLDG. NO.
	PRELIMINARY EXTENSION OF THE LANDFILL BASED ON A SITE RECONNAISSANCE
	PROPOSED WELL LOCATION*
	PROPOSED SOIL BORING LOCATION*
+	PROPOSED SOIL GAS SAMPLES*

*ALL PROPOSED LOCATIONS ARE APPROXIMATE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

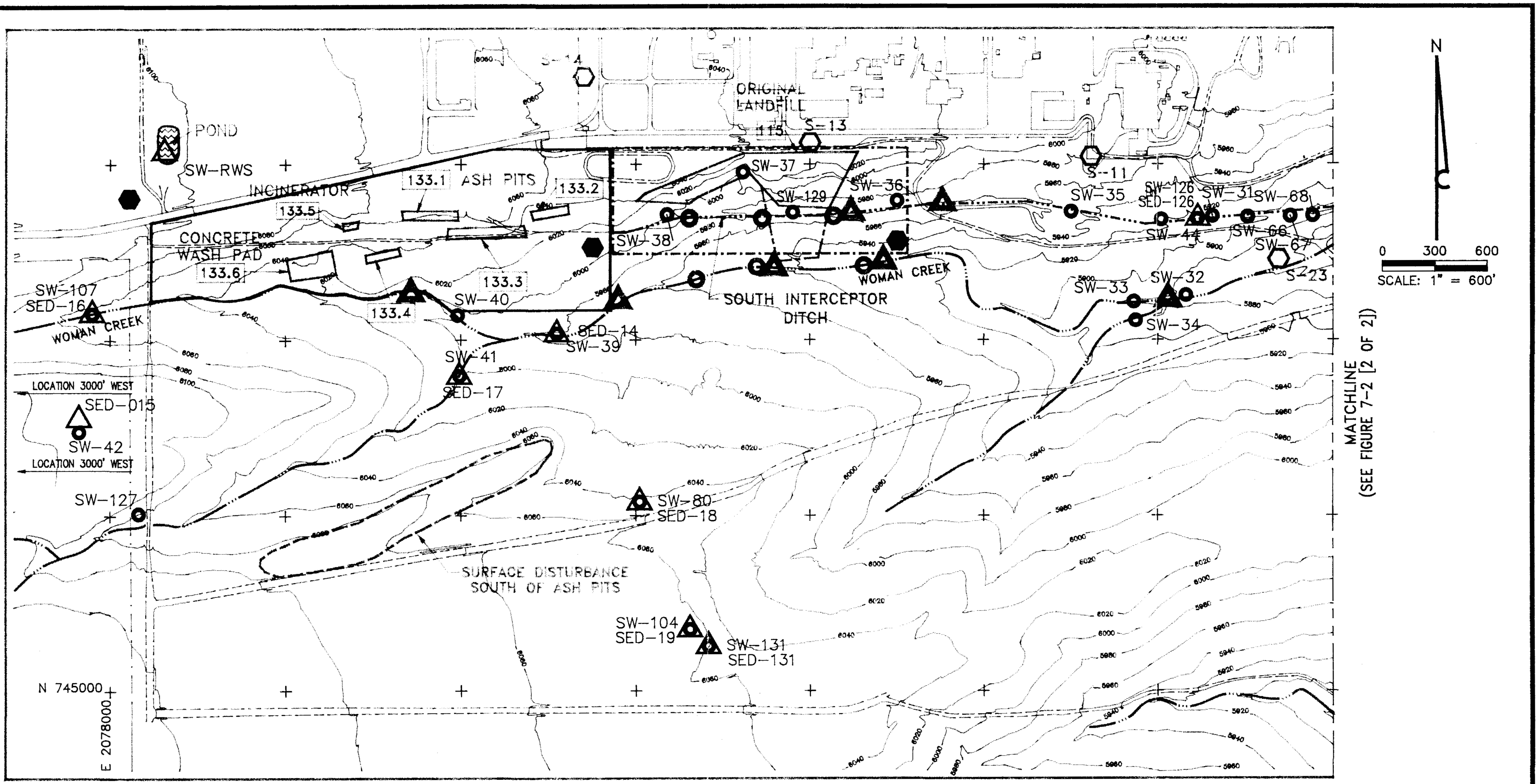
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING AND WELL LOCATIONS
IHSS 115
ORIGINAL LANDFILL

FIGURE 7-1

REV. AUGUST 1991
MARCH 1991

25060091



EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER LOCATION
SED-1	EXISTING SEDIMENT SAMPLING LOCATION
	INTERMITTENT STREAM
	DIRT ROAD
	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
S-23	EXISTING RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION
	PROPOSED SEDIMENT SAMPLE LOCATION
	PROPOSED RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION
	PROPOSED SURFACE WATER LOCATION
	PROPOSED GERMANIUM SURVEY FOR ASH PIT AREA
	1990 GERMANIUM SURVEY BOUNDARY AROUND OLD LANDFILL

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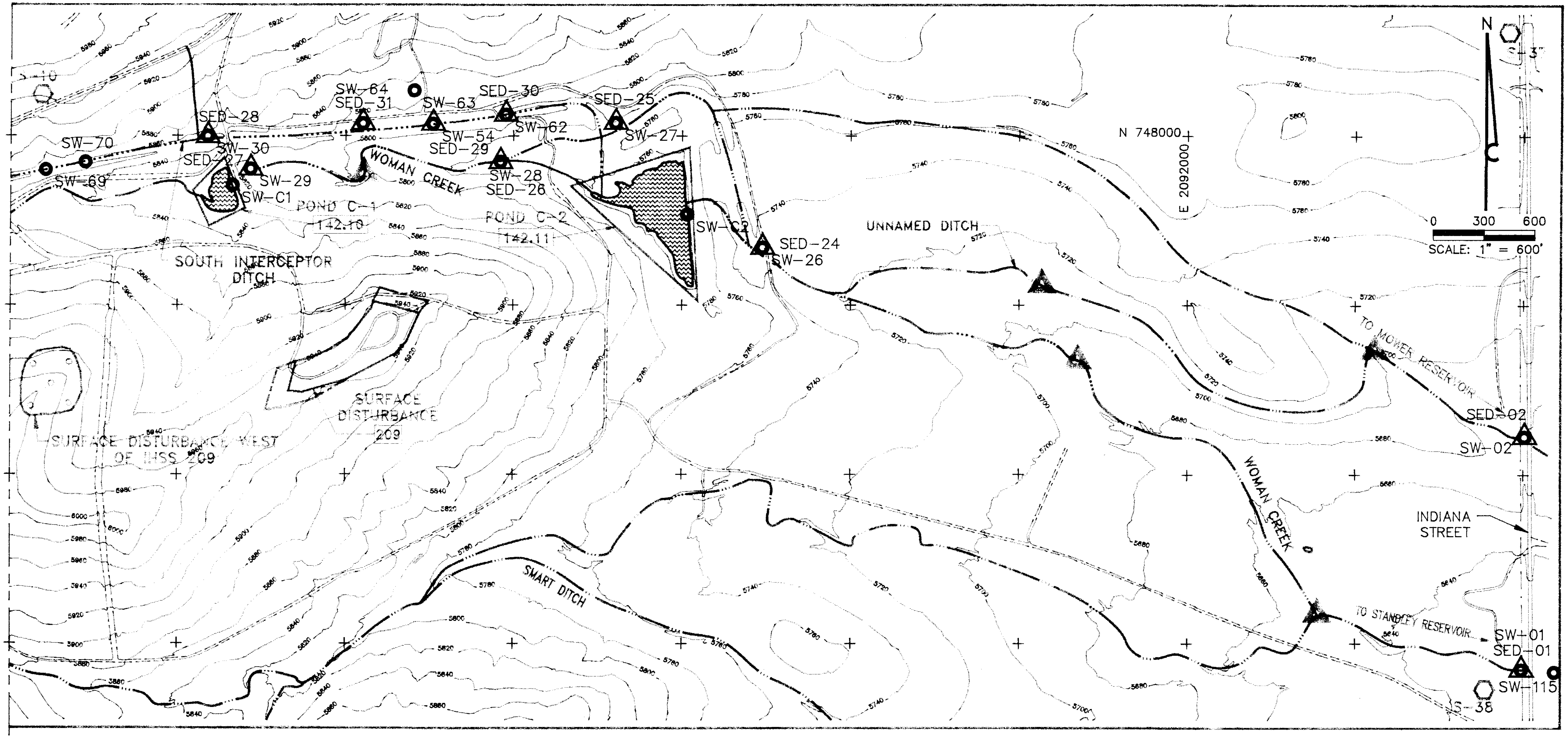
PHASE I RFI/RI WORK PLAN

SEDIMENT & SURFACE WATER SAMPLING SITES & AIR MONITORING STATIONS ALONG WOMAN CREEK AND THE SOUTH INTERCEPTOR DITCH

FIGURE 7-2 (1 OF 2)

REV. AUGUST 1991
MARCH 1991

2506010A



MATCHLINE
(SEE FIGURE 7-2 [1 OF 2])

EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER LOCATION
SED-1	EXISTING SEDIMENT SAMPLING LOCATION
	INTERMITTENT STREAM
	DIRT ROAD
	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
	ORIGINAL STREAM CHANNEL NEAR POND C-2
S-23	EXISTING RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION
	PROPOSED SEDIMENT SAMPLE LOCATION

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

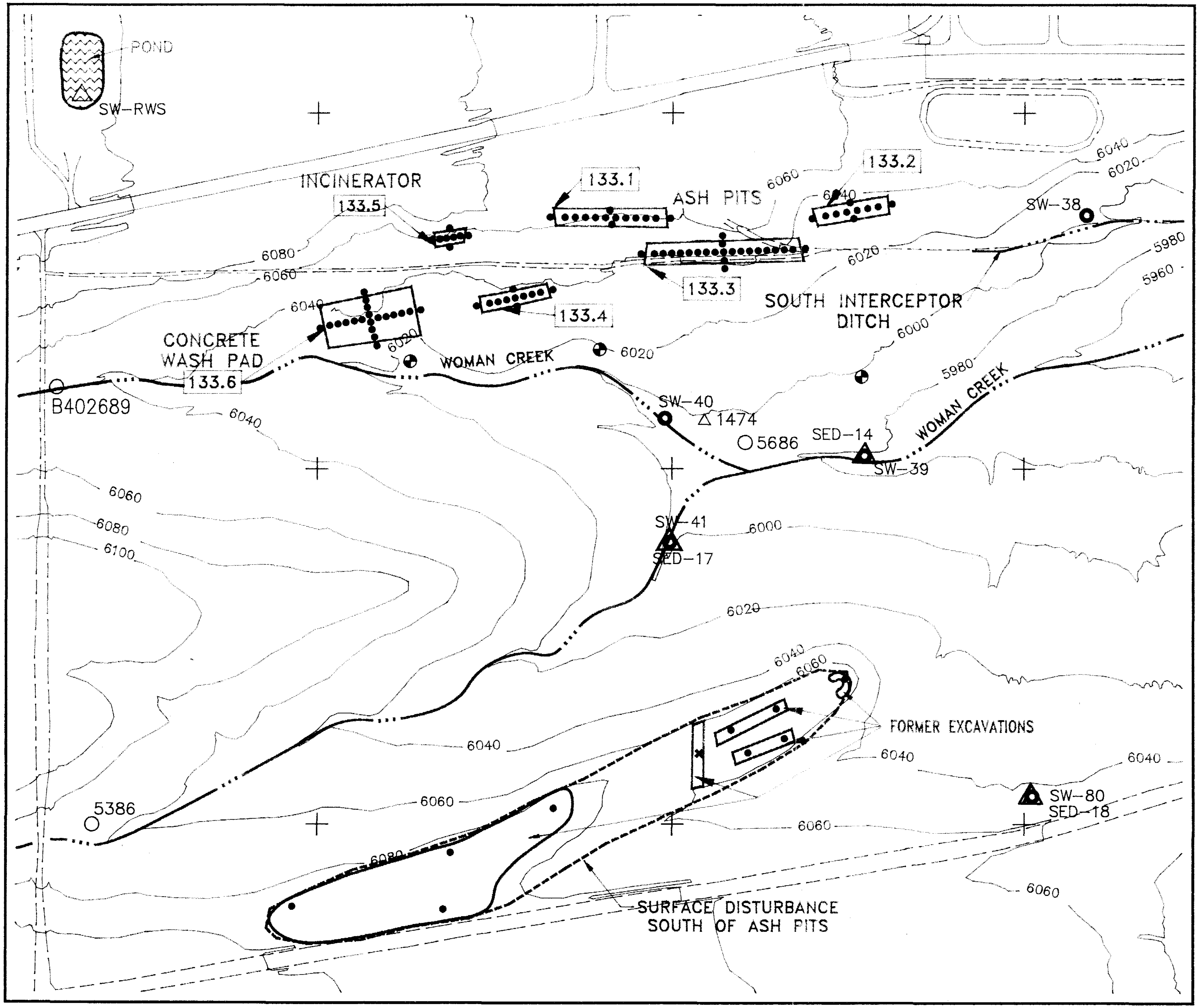
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

SEDIMENT & SURFACE WATER SAMPLING SITES & AIR MONITORING STATIONS ALONG WOMAN CREEK AND THE SOUTH INTERCEPTOR DITCH

FIGURE 7-2 (2 OF 2)

REV. AUGUST 1991
MARCH 1991

2506010B



N

0 150 300
SCALE: 1" = 300'

EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER SAMPLING LOCATION
5786	EXISTING ALLUVIAL GROUNDWATER MONITORING WELL
SED-17	EXISTING SEDIMENT SAMPLING LOCATION
1474	PRE-1986 MONITORING WELL
	PROPOSED SOIL BORING LOCATION
	PROPOSED WELL LOCATION
	PROPOSED SURFACE SAMPLING LOCATION
	INTERMITTENT STREAM
	DIRT ROAD

*ALL PROPOSED LOCATIONS ARE APPROXIMATE

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

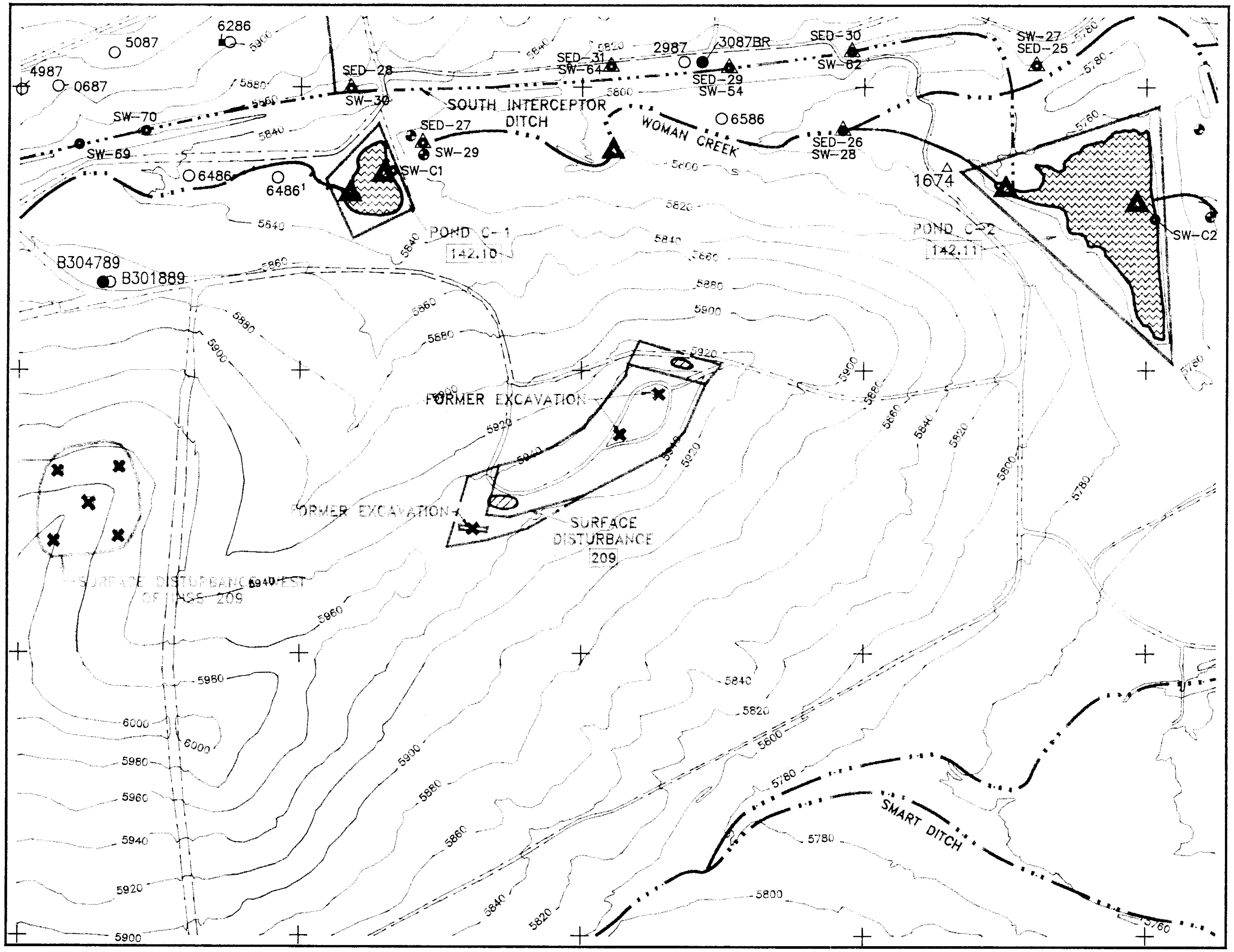
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

PROPOSED SAMPLING & WELL LOCATIONS, ASH PITS 1–4, INCINERATOR, CONCRETE WASH PAD (IHSS 133.1–6), AND ADDITIONAL SURFACE DISTURBANCE

FIGURE 7–3

REV. AUGUST 1991
MARCH 1991

25060111



N

0 200 400
SCALE: 1" = 400'

EXPLANATION

115 INDIVIDUAL HAZARDOUS SUBSTANCE SITE

SW-1 EXISTING SURFACE WATER SAMPLING LOCATION

5786 EXISTING ALLUVIAL GROUNDWATER MONITORING WELL

SED-17 EXISTING SEDIMENT SAMPLING LOCATION

3087 EXISTING BEDROCK GROUNDWATER MONITORING WELL

PONDLIKE DEPRESSION

INTERMITTENT STREAM

DIRT ROAD

PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A SITE RECONNAISSANCE

ORIGINAL STREAM CHANNEL NEAR POND C-2

PROPOSED SURFACE SAMPLE LOCATION

PROPOSED WELL LOCATION*

PROPOSED SEDIMENT SAMPLING LOCATION**

**3 OTHER LOCATIONS IN EACH POND WILL BE SELECTED AT RANDOM

*ALL PROPOSED LOCATIONS ARE APPROXIMATE

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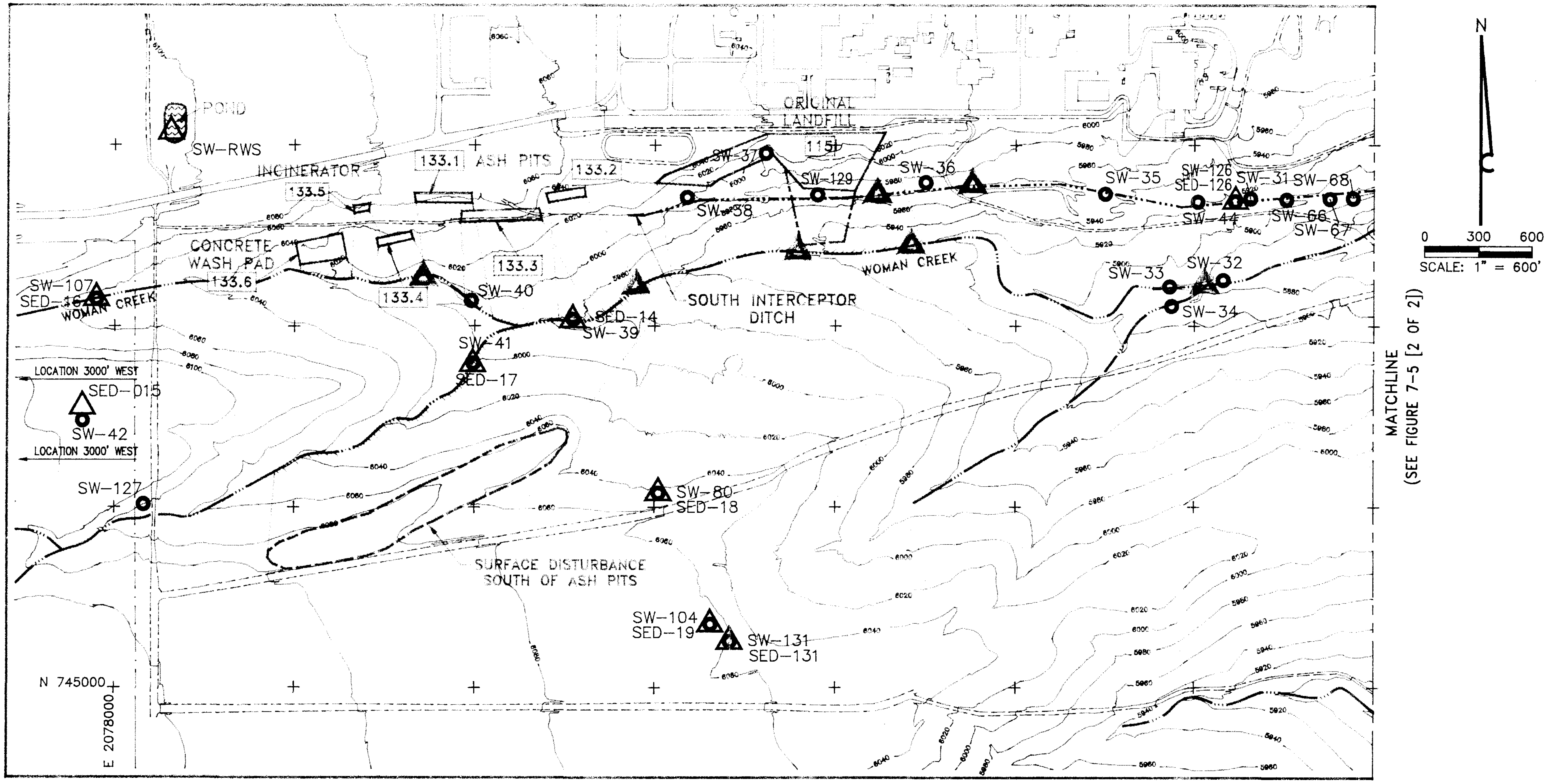
PROPOSED SAMPLING & WELL LOCATIONS, IHSS 142.10-11, PONDS C-1 & C-2, IHSS 209 SURFACE DISTURBANCE, & THE SURFACE DISTURBANCE WEST OF IHSS 209

FIGURE 7-4

REV. AUGUST 1991
MARCH 1991

25060121



EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER LOCATION
SED-1	EXISTING SEDIMENT SAMPLING LOCATION
	INTERMITTENT STREAM
	DIRT ROAD
	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
	POTENTIAL IMPACT AREAS FROM IHSSs
	PROPOSED SEDIMENT SAMPLE LOCATION

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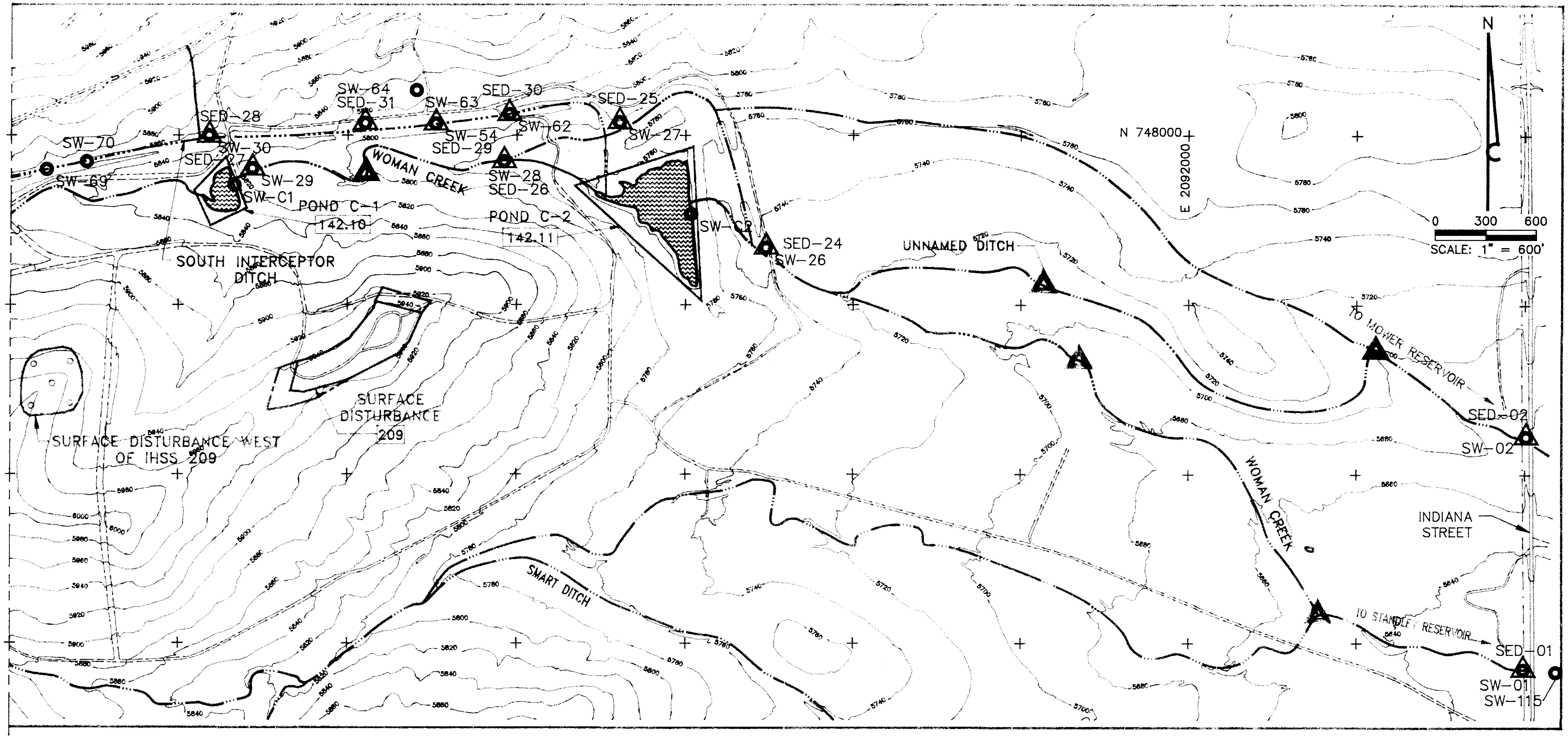
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

SEDIMENT SAMPLING SITES AND IHSS IMPACT AREAS ALONG THE SOUTH INTERCEPTOR DITCH AND NEARBY TRIBUTARIES

FIGURE 7-5 (1 OF 2) AUGUST 1991

2506014A



MATCHLINE
(SEE FIGURE 7-5 [1 OF 2])

EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER LOCATION
SED-1	EXISTING SEDIMENT SAMPLING LOCATION
	INTERMITTENT STREAM
	DIRT ROAD
	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON RECONNAISSANCE
	ORIGINAL STREAM CHANNEL NEAR POND C-2
	PROPOSED SEDIMENT SAMPLE LOCATION

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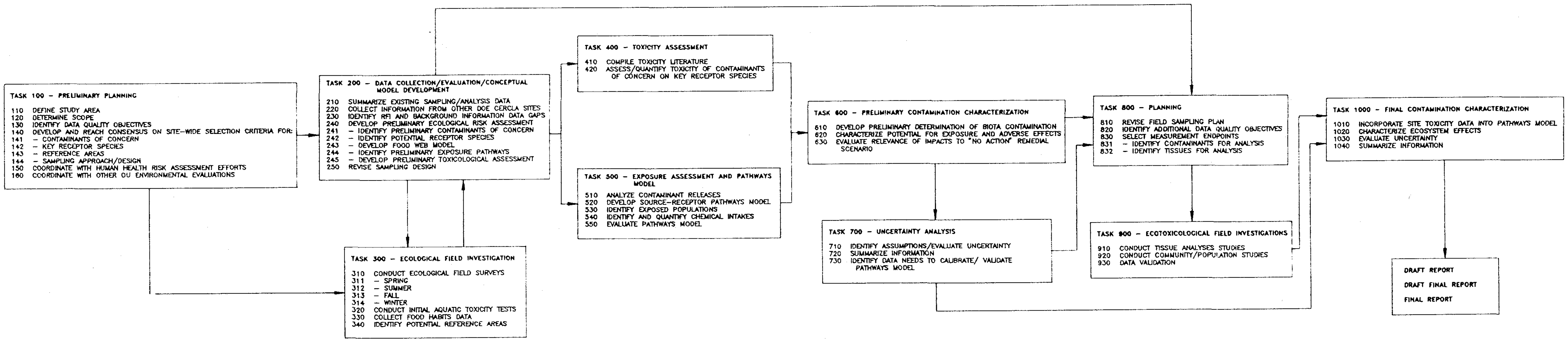
Rocky Flats Plant, Golden, Colorado

OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

SEDIMENT SAMPLING SITES AND IHSS IMPACT AREAS ALONG THE SOUTH INTERCEPTOR DITCH AND NEARBY TRIBUTARIES

FIGURE 7-5 (2 OF 2) AUGUST 1991

2506014B



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OPERABLE UNIT 5
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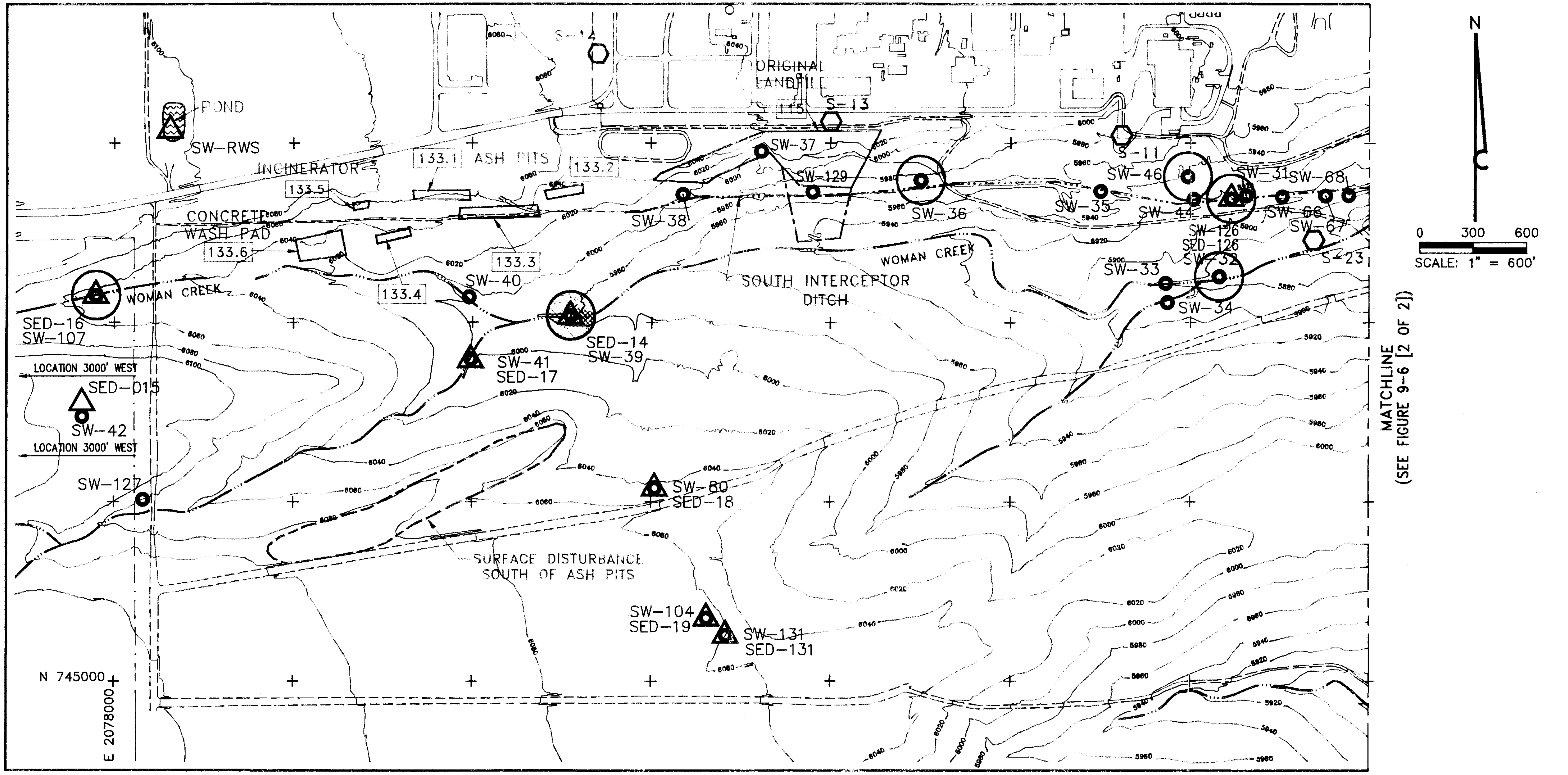
FLOW DIAGRAM:
INTERRELATIONSHIPS BETWEEN TASKS

FIGURE 9-1 MAY 1991

24990061



EXPLANATION

115 INDIVIDUAL HAZARDOUS SUBSTANCE SITE

SW-1 EXISTING SURFACE WATER LOCATION

SED-1 EXISTING SEDIMENT SAMPLING LOCATION

INTERMITTENT STREAM

DIRT ROAD

PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE

S-23 EXISTING RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION

SAMPLING LOCATIONS FOR AQUATIC BIOTA

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

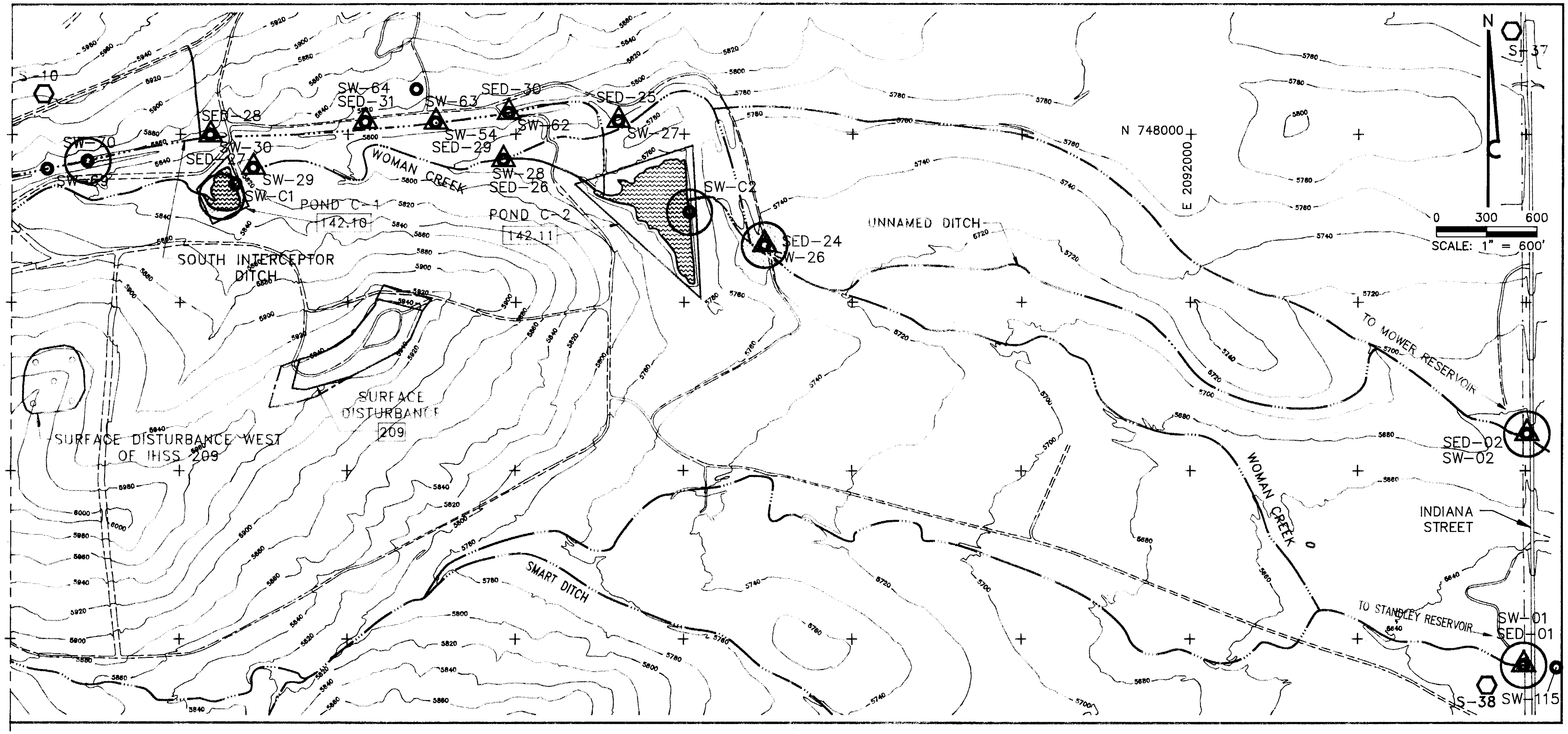
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

LOCATION MAP OF THE INDIVIDUAL HAZARDOUS SUBSTANCE SITES AND AQUATIC SAMPLING LOCATIONS

FIGURE 9-6 (1 OF 2)

REV. AUGUST 1991
MAY 1991

2506016A



MATCHLINE
(SEE FIGURE 9-6 [1 OF 2])

EXPLANATION

115	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
SW-1	EXISTING SURFACE WATER LOCATION
SED-1	EXISTING SEDIMENT SAMPLING LOCATION
	INTERMITTENT STREAM
	DIRT ROAD
	PRELIMINARY EXTENSION OF THE SURFACE DISTURBANCE BASED ON A RECONNAISSANCE
	ORIGINAL STREAM CHANNEL NEAR POND C-2
S-23	EXISTING RADIOACTIVE AMBIENT AIR MONITORING PROGRAM LOCATION
	SAMPLING LOCATIONS FOR AQUATIC BIOTA

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant, Golden, Colorado

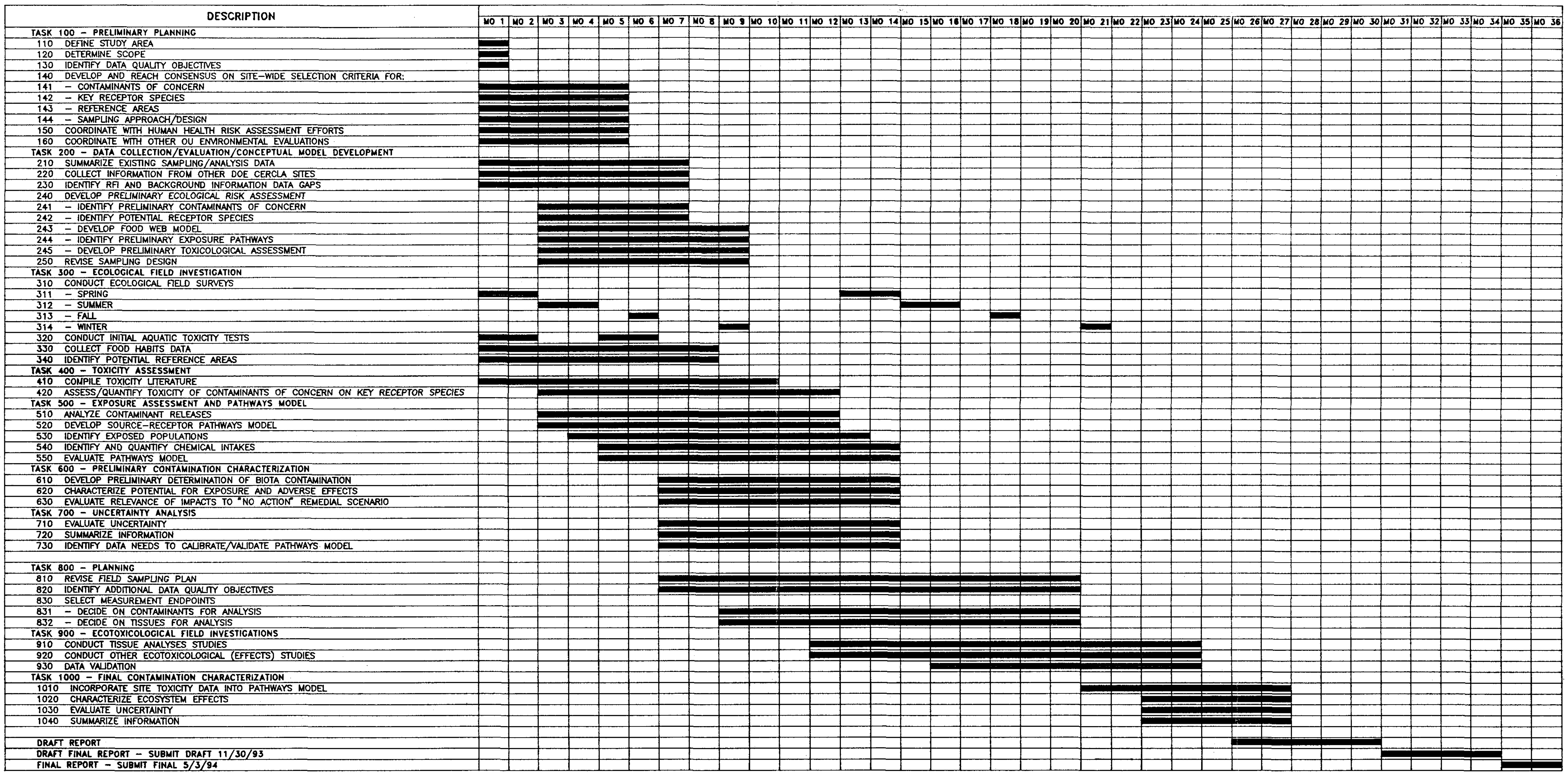
OPERABLE UNIT 5
PHASE I RFI/RI WORK PLAN

LOCATION MAP OF THE INDIVIDUAL HAZARDOUS SUBSTANCE SITES AND AQUATIC SAMPLING LOCATIONS

FIGURE 9-6 (2 OF 2)

REV. AUGUST 1991
MAY 1991

2506016B



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WOMAN CREEK PRIORITY DRAINAGE
ENVIRONMENTAL EVALUATION
ACTIVITY SCHEDULE

FIGURE 9-7 AUGUST 1991

2506E690